НАУКОВО–ВИРОБНИЧИЙ ЖУРНАЛ

Зернові продукти і комбікорми

ISSN 2313-478X (print)
ISSN 2411-3921 (online)
ISO: 26324-2012

якість * виробництво * використання * технології * обладнання * автоматизація * управління * економіка

Volume 22, Issue 3 / 2022
№ 87 / Вересень / September

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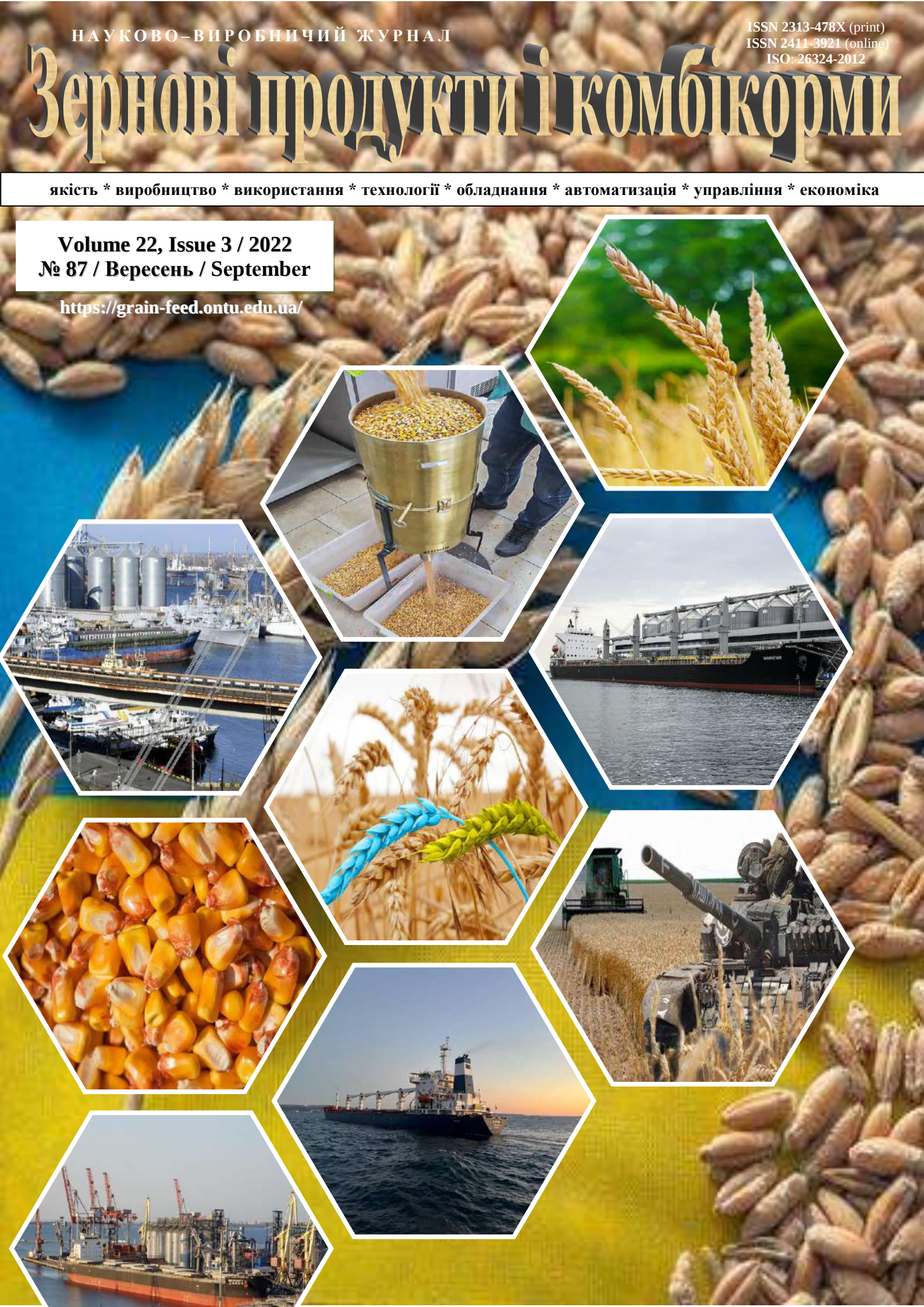

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Щоквартальний науково-виробничий журнал Одеського національного технологічного університету

Рік заснування – 2000

Зареєстровано Міністерством юстиції України 16.05.2007 р.
Свідоцтво: Серія КВ, № 12576-1460Р

ISSN 2313-478X (print)
ISSN 2411-3921 (online)
ISO: **26324-2012**

Volume 22, Issue 3 (87) / 2022
Вересень / September

Зернові продукти і комбікорми
Grain Products and Mixed Fodder's

ЯКІСТЬ * ВИРОБНИЦТВО * ВИКОРИСТАННЯ * ТЕХНОЛОГІЇ * ОБЛАДНАННЯ * АВТОМАТИЗАЦІЯ * УПРАВЛІННЯ * ЕКОНОМІКА*

Адреса редакції:
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За достовірність інформації відповідає автор публікації. Передрукування матеріалів журналу дозволяється тільки за погодженням з редакцією. Підписано до друку та розповсюдження в мережі Internet рішенням Вченої ради ОНТУ від 04.10.2022 р., пр. № 2. Формат 60 х 84/8. Папір офсетний. Гарнітура TNR. Друк цифровий. Тираж 100 прим. Зам. № 77. Надруковано ФОП Попова Н.М.

CONTENT

ЗМІСТ

Журнал „Зернові продукти і комбікорми" згідно до наказу МОН України № 1301 від 15.10.2019 (Додаток 8) входить до списку друкованих (електронних) періодичних видань, що включаються до Переліку наукових фахових видань України категорії Б, в яких можуть публікуватися основні результати дисертаційних робіт на здобуття наукових ступенів доктора і кандидата технічних наук спеціальності 181

Підписний індекс в каталозі Укрпошти 91963

http://journals.gsjp.eu/index.php/gpmf/index

https://grain-feed.ontu.edu.ua

Grain Storage Forum Elevator 2022

Дата проведення: 17 лютого, 2023 р.

Організатори: ProAgro Group | Асоціація елеваторів України | Українська зернова асоціація

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Захід організовується у співпраці з Українською зерновою та Елеваторною асоціаціями і за підтримки Міністерства аграрної політики України. Форум створений для компаній зі зберігання та переробки зерна, які прагнуть представити свою продукцію та послуги й розширити клієнтську базу.

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Саміт включатиме:

4 Конференції:
«Зберігання зерна»,
«Переробка зернових та олійних»,
«Трейдинг та логістика»;
«Біоенергетика»;

Круглі столи з лідерами думок, експертами з інновацій;
Виступи понад 60 спікерів з кейсами ефективного ведення агробізнесу;
Виставка Grain Storage Expo;
VIP зона для бізнес переговорів;
Пресконференція;
Учасники Форуму – аграрна спільнота з України та Світу;
Кава-паузи, фуршети, коктейлі та розважальна програма.

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Діалоги УЗА: *з аграрним комітетом ВРУ, з компанією «НІБУЛОН»*

Дискусійні панелі:

«Логістика та інфраструктура»
«Торгівля та експорт»

Презентація Project Expedite Justice щодо компенсації аграріям втрат від війни

Конференція «Зберігання зерна»

І Панель – Зберігання зерна. Проблеми та можливості розвитку в період війни
ІІ Панель – Сучасні інновації та ефективність зберігання. Енергобезпека

Конференція «Переробка зернових та олійних. Біоенергетика»

І Панель – Посилення переробки зерна – безальтернативність, яка вирішує питання.
ІІ Панель – Енергоефективність та енергобезпека. Зелена енергетика – один з головних трендів.

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ПРОГРАМА ФОРУМУ

8:00-9:30 РЕЄСТРАЦІЯ УЧАСНИКІВ

9:30 *Відкриття Форуму. Діалог УЗА з аграрним комітетом ВРУ*

Олександр Гайду, голова комітету ВРУ з питань аграрної і земельної політики

Микола Горбачьов, президент Української зернової асоціації

10:00-12:00 *Конференція «Трейдинг і логістика»*

Діалог УЗА з компанією «НІБУЛОН»

Микола Горбачьов, президент Української зернової асоціації

Андрій Вадатурський, генеральний директор «НІБУЛОН»

Дискусійна панель «Логістика та інфраструктура»

Юрій Васьков, заступник міністра інфраструктури України

Вячеслав Єрьомін, операційний директор «Укрзалізниці»

Микола Мірошниченко, директор з логістики «Кернел»

Михайло Різак, заступник генерального директора «НІБУЛОН»

Максим Волченко, директор «Алмейда Груп»

Дискусійна панель «Торгівля та експорт»

Тарас Качка, заступник міністра економіки України, торговий представник України

Сергій Феофілов, генеральний директор «УкрАгроКонсалт»

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Презентація Project Expedite Justice: «Грабіж як військовий злочин: збір доказів, шляхи притягнення до відповідальності та компенсаційні механізми»

Паскаль Турлан, директор програми Project Expedite Justice

Аліса Голощапова, проєктний координатор Project Expedite Justice

12:00-13:00 ПЕРЕРВА. ФУРШЕТ

13:00-15:00 *Конференція «Зберігання зерна»*

Дискусійна панель «Зберігання зерна. Проблеми та можливості розвитку в період війни та повоєнного часу»

Володимир Сущенко, заступник генерального директора з елеваторного та комбікормового виробництва «УкрЛендФармінг»

Світлана Нікітюк, керівник центрального офісу «Епіцентр Агро»

Владислав Карпенко, керівник напряму з розвитку продуктивності і доступу до ринків програми USAID AGRO

Роман Сластьон, генеральний директор УКАБ

Дмитро Кобзар, генеральний директор Контейнерного терміналу «Мостиська»

Таїр Мусаєв, комерційний директор BZK Grain

Сергій Щербань, керівник елеваторного напрямку групи SOLAGRO

Олег Клименко, президент Асоціації елеваторів України, директор ProAgro

Дискусійно-презентаційна панель «Сучасні інновації та ефективність зберігання»

Валерій Яковенко, співзасновник DroneUA

Юрій Шимченко, голова представництва Convex International в Україні

Вячеслав Степанчук, директор з монтажу та будівництва «KMZ Industries»

Василь Попов, директор EDS PLUS

Олександр Холод, генеральний директор TORNUM

Олег Щербатенко, CEO IT-Enterprise, голова правління АППАУ

15:00-15:30 ПЕРЕРВА. ФУРШЕТ

15:30-17:30 *Конференція «Переробка, біоенергетика та енергобезпека»*

Дискусійна панель «Посилення переробки зерна, безальтернативність, яка вирішує питання»

Леонід Козаченко, президент Української аграрної конфедерації

Андрій Шаран, керівник офісу «Бюлер Україна»

Олег Левченко, директор Aria Commodities

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Юрій Подоляк, директор ІКНЕТ

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Євген Лукашевич, директор «Української технологічної компанії» (UTC)

Георгій Гелетуха, голова правління Біоенергетичної асоціації України

Тарас Миколаєнко, директор Української асоціації виробників біоетанолу

17:30-19:00 КОКТЕЙЛЬ

UDC: 338.246.8:341.38:[332.12:338.244.47](477.7)
DOI https://doi.org/10.15673/gpmf.v22i3.2455

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STUDY OF TIME CHARACTERISTICS OF GRAIN RECEIVING FROM AUTO TRANSPORT AT PROCUREMENT ELEVATORS

Abstract

At harvesting elevators and grain receiving enterprises, the operation of receiving grain from motor vehicles is the main one. Many elevators of other types also accept grain from motor vehicles due to the fact that it allows to improve the economic performance of the enterprise, and in general, the combination of functions inherent in elevators of different types is a feature of enterprises in the elevator industry of our country. For almost all elevators or grain terminals, the issue of car queues before the entrance is acute. The introduction of various high-performance car unloaders helps to increase the capacity of elevators for unloading grain from cars and road trains of all types. The process of receiving grain from vehicles consists of several operations, and each operation in this chain is important in reducing the time the vehicle stays at the enterprise, and therefore, increasing its throughput. We analyzed the process of unloading cars on U-15URAG-U car unloaders installed at two procurement elevators in the Mykolaiv and Zhytomyr regions. In the course of carrying out this scientific study, we timed the unloading process of 20 single cars (that is, without trailers), which were used to deliver grain to the enterprise. The main stages of unloading cars in the reception facilities of the studied enterprises were highlighted and the average (most reliable), minimum and maximum execution time of each stage was determined. Schedules of the unloading of vehicles with wheat grain at the harvesting elevators, where the research was carried out, were constructed. The results of the timing of the unloading of cars in the receiving device showed that the longest stage is the lifting of the platform of the car loader and the pouring of grain, and the least lasting is the exit of the driver from the cab. The average unloading time was 561.5 seconds for the first enterprise (Mykolaiv Region) and 565 seconds for the second (Zhytomyr Region). It should be noted that the time of raising and lowering the platforms of U15-URAG-U truck unloaders at both considered enterprises corresponds to the passport data, that is, the truck unloaders are not working at maximum efficiency.

Key words: receiving grain, receiving device, car unloader, timing.

Introduction

In Ukraine, in recent years (before the beginning of the Russian Federation's full-scale aggression against our country), a steady trend of increasing the volume of grain production was observed. That led to an increase in the load on vehicles used to transport grain from the field to elevators and other grain storage facilities, to transshipment points for other types of transport.

Grain transportation across Ukraine is carried out in 3 ways − by rail, water and motor transport. The choice depends on the distance and the final point of transportation. The leading position is occupied by the transportation of grain by railway transport, but in recent years we have observed a reorientation towards motor vehicles [1].

Road transport is the most popular mode of transport in the supply chain of grain and oil crops used by suppliers and enterprises. Road transport of grain is divided into 2 types of shipments: "from the field" and "from the elevator". The main distinguishing feature from other types of logistics is the construction of flexible routes between settlements and cities, operational organization of transport and delivery to the loading/unloading point, selection of transport dimensions according to the technical characteristics of the customer enterprise [2].

Literary review

Thus, in 2021, the specific weight of motor vehicles in the transportation of goods amounted to 74% (134,398.22 thousand tons), of which grain cargoes accounted for 12,680.79 thousand tons [3].

It is especially important to remember that grain, which during the harvest campaign is transported directly from the fields, needs to be quickly taken to the elevator for further processing (cleaning, drying, active ventilation) in order to prevent deterioration of its quality.

Advantages of grain transportation by road [2]:

− prompt delivery of cargo to the port (for example, spot trading);

− direct loading of the crop in the field (supplies of truck grain trucks are carried out directly under the harvester);

− internal movements over short distances;

− prompt coordination of delivery conditions, terms, types of cars according to the client's conditions, cost of transportation;

− preservation and safety of movement of grain cargoes, GPS monitoring of each car and cargo online;

− operational document flow, absence of additional bureaucracy when preparing documents for freight transportation;

− individual approach to pricing depending on the distance of movement and volume of cargo;

− state road construction programs allowed to carry out a route within a day to remote delivery points along strategic routes;

− availability in working with private enterprises and agricultural producers.

Disadvantages of automobile grain logistics:

− possible delays in the delivery of cargo to final destinations due to the need to comply with the conditions of the "thermal regime" in the summer season;

− the mass of grain transported by a single car should not exceed 25 tons, which leads to an increase in the number of motor vehicles and the number of cars when moving a large volume of grain;

− shortage of cars at the request of shippers during the "high season";

− transfer payment in case of returning cars from reception points back to the farm;

− probability of cargo loss in case of force majeure and unforeseen circumstances;

− increase in transportation tariffs depending on changes in the price of PMM;

− the cost of transportation is higher than by railway wagons.

At the same time, it is necessary to state the fact that if 5-6 years ago there was an acute shortage of grain transport vehicles in agricultural companies, today this problem has been partially overcome. More and more often, farm owners realize that having their fleet of grain trucks significantly expands their capabilities, reducing dependence on third-party companies and making grain transportation by motor vehicle cheaper.

Not all farms have the opportunity to purchase the required number of grain trucks. However, there have been obvious changes in this area. In particular, this concerns the development of domestic enterprises producing platforms and trailers, as well as the reorientation of the market to the production and purchase of grain transportation equipment with a lightweight design.

The duration of loading the car body with grain depends on the features of the grain harvester design and can vary from two to five minutes.

The introduction of mechanization of unloading operations, the use of dump trucks and unloading platforms allows to reduce the time for unloading grain from a vehicle. In order to avoid loss and spoilage of grain during transportation, the bodies of cars, trailers and semi-trailers should be equipped with seals and have awnings that protect the grain from atmospheric precipitation [1, 2].

To transport grain over long distances, grain carriers-road trains are used, which are equipped with a special body in the form of a tank or a bunker. There are three types of bodies of grain trucks: stationary, trailer, semi-trailer. There are two options for their execution: closed and open. The grain semi-trailer is equipped with an awning with a mechanical winding device. According to the method of unloading, there are grain trucks with rear and side unloading.

Currently, tractors with dump semi-trailers of large capacity and capacity (European grain trucks produced by the companies "Daf", "Scania", "Renault", "Man") have become widespread. These grain trucks and semi-trailers can unload grain independently, which allows to reduce time costs [4].

The fleet of grain trucks is diverse, body volumes are up to 60-70 m3, load capacity is up to 40-45 t, the height of the side is from 2.7 to 4 m. The peculiarity of the design of Euro grain trucks makes it possible to lift them with the help of a hydraulic device during dump unloading. 12-meter semi-trailers up to an angle of 60 degrees, which significantly facilitates the unloading of grain [1].

It should be noted that the largest share of grain is transported by road transport during the harvesting campaign, that is, in a very short period of time, a large number of cars of various types and carrying capacities, which require quick unloading, arrive at the harvesting elevators.

It is especially important to remember that the grain, which during the harvesting campaign is transported directly from the fields, needs to be quickly taken to the elevator for further processing (cleaning, drying, active ventilation) in order to prevent deterioration of its quality.

Thus, it depends on the correct organization of the operation of receiving grain from road transport, whether the enterprises will be able to accept, place and process all the grain of various purposes and quality coming from producers, with minimal losses of grain and downtime of road transport.

The successful implementation of receiving grain from road transport depends on the number and performance of the equipment of receiving devices, which must correspond to the nature of the incoming motor vehicle: its type and carrying capacity, the number and volume of batches of grain of various crops delivered to the enterprise, and the quality of the grain [5-9].

Formulation of the problem

The purpose of the work is to study the efficiency of the car unloaders at harvesting elevators by determining the timing characteristics of receiving grain from vehicles.

The object of our research is receiving devices from motor vehicles at two procurement elevators located in the Mykolaiv and Zhytomyr regions, with installed U-15URAG-U car unloaders.

Objectives of the study:

− determination of arithmetic mean values of the duration of each stage of car unloading;

− determination of the total time of external operation of the receiving device from motor vehicles;

− performing an assessment of the average variability σ of the results and calculating the coefficients of variation V for each stage of car unloading;

− determining the average productivity of unloading cars.

Materials and methods

The main methods of researching the efficiency of the reception device are: timing of the process of unloading cars and the grapho-analytical method.

Timing of the process of unloading cars is carried out using the current time method, that is, recording the start and end time of each stage [5-7]. Most often, the

moment of the end of one stage coincides with the beginning of the next. Depending on the duration of the stages and the entire process of unloading the car, the time is recorded in minutes and seconds. Thus, the unloading process of at least 20 cars of the same type is timed.

The grapho-analytical method consists in constructing cyclogram graphs that visually show the sequence and average (arithmetic) duration of all stages of car unloading.

Results of the study and their discussion

In the course of carrying out this scientific study, we timed the unloading process of single cars (that is, without trailers), which were used to deliver wheat grain with a moisture content of 12.4...13.8% to enterprises – 20 cars each with a carrying capacity (net) of 20.23 to 30.8 tons at each of the procurement elevators considered.

We identified the following main stages in the process of unloading cars in the receiving devices of these elevators:

1. Entry of the car onto the platform;
2. Driver leaving the cab;
3. Fixing the car on the platform with a chain;
4. Opening the side of the car;
5. Lifting the platform of the car unloader and dumping the grain;
6. Lowering the platform;
7. Closing the side of the car;
8. Removing chains;
9. Driving off the platform.

Based on the timing sheets, the duration of each stage of car unloading was determined in seconds and the total duration of car unloading was calculated.

Further, mathematical processing of the data was carried out, during which an estimate of the average variability (ie, the calculated mean squared (standard) deviation) of the results σ was performed and the coefficients of variation V were calculated for each stage of car unloading.

The mean square (standard) deviation of the results σ was calculated according to the formula:

$$\sigma = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}, \quad (1)$$

where x_i — is the duration of a separate unloading stage of the i-th car;

$\bar{x}$ — is the average arithmetic value of the duration of the car unloading stage;

n — the number of researched cars, pcs.

The coefficient of variation V was determined by the formula:

$$V = \frac{\sigma * 100}{\bar{x}}, \ \% \quad (2)$$

The smaller the deviation of each option from the arithmetic mean, the smaller the coefficient of variation will be. In technology, the value of variation coefficients can be used to characterize the stability of regimes, grain quality indicators, equipment efficiency indicators, reproducibility of methods, etc. With good parallel results of determinations, the value of the coefficient of variation ranges up to 10%.

Then, the minimum and maximum duration of each stage of car unloading and the arithmetic mean (most reliable) time of their execution were determined, according to which schedules of the external operation of the receiving device from motor vehicles for unloading cars with grain were then constructed.

Table 1 – Main technical characteristics of the U15-URAG-U car unloader [10]

Parameter names	U15-URAG-U
Technical productivity, t/h	330
Nominal load capacity (max, at maximum pressure), t, no more - a large platform - side platform	70(80) 50 20
Platform length, mm: - a large platform - side platform	 15700 6400
Tilt time, s, no more than: - a large platform - side platform	 180 20
Descent time, s, not more than: - a large platform - side platform	 150 15
Angle of inclination of the platform, degrees.	0…38
Motor	hydraulic
Number of telescopic three-plunger hydraulic jacks, pcs.: - a large platform - side platform	 2 1
Diameter of the plunger of the first stage, mm Working stroke of the plunger of the first stage, mm Diameter of the plunger of the second stage, mm Working stroke of the plunger of the second stage, mm Diameter of the plunger of the third stage, mm Working stroke of the plunger of the third stage, mm	235 2217 190 2340 150 2418
Nominal pressure in the hydraulic system, MPa (kg/cm^2) Maximum (safety valve trigger pressure), MPa (kg/cm^2)	10(100) 12,5(125)
Hydro system capacity, l	600
Drive control type	electric
Nominal voltage, V: power chain control chain	 380 220
Nominal power of the electric motor, kW	30
Degree of protection of electrical equipment	IP55
Mass, kg, no more	2200

At the last stage of the work, we determined the average carrying capacity of the car $G_{average}$ and calculated the average unloading productivity $Q_{average}$ according to the formulas:

$$G_{average} = \frac{\sum G}{n}, \text{ t} \quad (3)$$

where ΣG — total carrying capacity of all cars, t;
n — number of cars, pcs.

$$Q_{ср} = \frac{3600 * Г_{ср}}{Т^{external}_{average}}, \text{ t/h}, \quad (4)$$

where $G_{average}$ – average (arithmetic) carrying capacity of the car, t;
$Т^{external}_{average}$ – average (arithmetic) total duration of car unloading, p.

At present, at grain storage and processing enterprises, the main part of the total volume of loading and unloading operations is provided with the use of truck unloaders of various types, designs and modifications, carrying capacity and performance, of which there are currently about forty.

At the enterprises where the research was conducted, the most unified and most adapted from the point of view of practicality of use and ease of operation, as well as economic expediency, widely known and most often used in the production activities of most enterprises, the U-15URAG-U car unloader was installed.

The U-15URAG-U car unloader is designed for unloading grain through the open rear side of single cars and tractor-trailers with semi-trailers and unloading through the open side side of single cars and trailers without uncoupling the trailers from cars. The main technical characteristics of the U15-URAG-U car unloader are listed in table. 1 [10].

According to the timing sheets, we determined the duration of each stage and the total time of unloading the cars, after which mathematical processing of the received data was performed. The calculations showed the stability of the performance of each stage of car unloading, as the obtained coefficients of variation did not exceed 10%.

On the basis of the data obtained during the study of the timing of the process of unloading cars, we determined the minimum and maximum times for each stage of unloading cars and the arithmetic mean time of their execution, as well as calculated the total duration of unloading cars with grain of different crops and different moisture content. The results of these calculations are given in table. 2.

According to the table 2 (on the basis of the arithmetic mean time of all operations) schedules of the unloading of vehicles with wheat grain at the harvesting elevators where the research was conducted are plotted (Fig. 1).

Analysis of the graphs showed that stage (5) of raising the platform of the car unloader and dumping grain took the longest at both enterprises – 148.1 s and 157.5 s, respectively, for the first and second enterprises. In second place in terms of duration is stage (6) of lowering the platform – 147.8 s on the first elevator and 150 s on the second. The shortest stage (2) is the exit of the driver from the cabin and it is 8.3 s on the first elevator and 7.8 s on the second.

It should be noted that the actual time of raising and lowering the platform at the considered enterprises is less than the passport data - 180 s and 150 s, respectively. The average duration of unloading cars was 554.8 seconds for the first company (Mykolaiv Region) and 564.9 seconds for the second (Zhytomyr Region).

Based on the obtained data, the average loading capacity of the truck unloader and its unloading performance were determined. It was established that for the first enterprise (Mykolaiv region) the average carrying capacity of the car is 23.48 tons, and the average unloading productivity is 152.4 tons/hour. For the second enterprise (Zhytomyr region), the average carrying capacity of the car is 30.8 t, the average unloading productivity is 196.24 t/h.

Conclusions

In order to establish the efficiency of the U-15URAG-U car unloaders, a study was conducted of the timing characteristics of receiving wheat grain with a

Table 2 – Data on the timing of the unloading of cars at the receiving devices of procurement elevators

Performed operations	Duration of operations, p					
	Enterprise I (Mykolaiv Region)			Enterprise II (Zhytomyr Region)		
	min	max	arithmetic mean	min	max	arithmetic mean
1. Entry of the car onto the platform of the car unloader	40	40	40	40	40	40
2. Driver leaving the cab	5	10	8,3	6	9	7,8
3. Fixing the car on the platform	40	70	56	55	65	60
4. Opening the side of the car	20	40	32	25	32	28,5
5. Raising the platform and dumping the grain	144	153	148,1	150	165	157,5
6. Lowering the platform	144	150	147,8	150	150	150
7. Closing the side of the car	30	39	31,9	23	30	26,5
8. Removal of chains	50	68	55,2	48	60	54,6
9. Driving off the platform	30	60	37	28	54	40
Total duration of the cycle	**546**	**570**	**554,8**	**525**	**605**	**564,9**

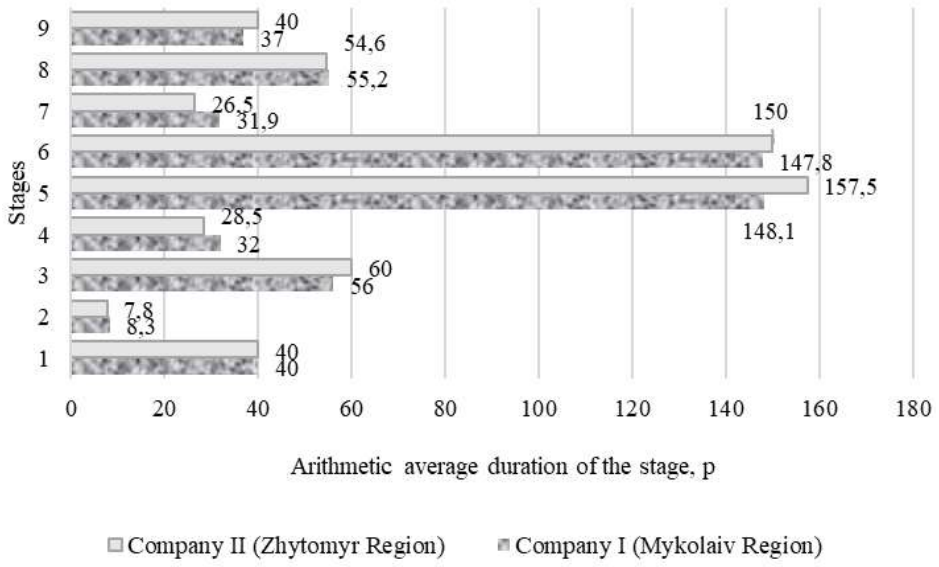

Fig. 1 – Schedules of the unloading of vehicles with wheat grain at harvesting elevators in the Mykolaiv and Zhytomyr regions

moisture content of 12.4...13.8% from cars with a carrying capacity (net) of 20.23 to 30.80 tons at two harvesting elevators located in the Mykolayiv (I enterprise) and Zhytomyr regions (II enterprise).

Based on the results of these studies, the average arithmetic values of the duration of each of the stages of car unloading were determined, and this made it possible to establish that:

- the longest is the stage of lifting the platform of the truck unloader and dumping grain - 148.1 s and 157.5 s, at the first and second enterprises, respectively, but its duration does not exceed the passport data of the truck unloader - 180 s;

- the platform lowering time is 147.8 and 150 seconds, respectively, at the first and second enterprises, and corresponds to the technical characteristics of the U-15URAG-U truck unloader;

- the least long stage is the driver's exit from the cab, which is 8.3 s and 7.8 s at the 1st and 2nd enterprises, respectively.

The total average (arithmetic) duration of car unloading that we established was 9.25 min (554.8 s) for the first enterprise and 9.42 min (564.9 s) for the second.

The calculations showed the stability of the performance of each stage of car unloading, as the obtained coefficients of variation did not exceed 10%.

The estimated average (arithmetic) actual productivity of U-15URAG-U truck unloaders turned out to be significantly less than the passport productivity of Q_{tech}=330 t/h (152.4 t/h for the first enterprise and 196.24 t/h for the second). This is explained by the fact that the passport productivity of truck unloaders is given without taking into account the time lost for performing operations that are not specifically related to the work of the truck unloader.

U-15 URAG-U truck unloaders in the receiving devices of the researched harvesting elevators work stably, and the operation of the elevators for receiving grain from vehicles is established.

REFERENCES

1. Voinolovuch O. Bezpeka pratsi pid chas perevezennya zerna avtotransportom. Chastuna 1. Ohorona pratsi i pozhezhna bezpeka // Elektronniy resurs. Rezhim dostupu: https://oppb.com.ua/articles/bezpeka-praci-pid-chas-perevezennya-zerna-avtotransportom-chastyna-1.
2. Logistuka zerna. Sposobu transportuvannya zernovuh // Elektronniy resurs. Rezhim dostupu: https://www.05366.com.ua/list/331917.
3. Transport i zvyazok Ukrainu 2018. Statustuchnuy zbirnuk // Elektronniy resurs. Rezhim dostupu: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/08/zb_tr2018pdf.pdf.
4. Logistuka export zerna // Elektronniy resurs. Rezhim dostupu: https://ambarexport.ua/ru/blog/grain-export-logistics.
5. Stankevich G., Strahova T., Buduk L. Dunamika i period nadhodzhennya zerna avtomobilnum transportom na pidpruemstva pivdennuh ta tsentralnuh regioniv Ukrainy. Naukovi pratsi Odeskoi natsionalnoi akademii harchovuh tehnologii. 2011 // Elektronniy resurs. Rezhim dostupu: https://www.onaft.edu.ua›abstract›Abstract-Shpak.
6. Butsenko I.M. Doslidzhennya propusknoi zdatnosti pruimannya zerna z avtomobilnogo transportu na PrAT Ukrelevetorprom. Hranenie i pererabotka zerna. 2013. 11. P.26-28.
7. Butsenko I.M. Doslidzhennya propusknoi zdatnosti pruimannya zerna z avtomobilnogo transportu na PrAT Ukrelevetorprom. Naukovi pratsi ONAHT. Odesa. 2013. 44. P.87-90.
8. Strahova T., Borta A.V., Shpak V.M. Analiz ephektuvnosti robotu tehnologichnoi linii pruimannya zerna z avtomobilnogo transportu na PrAT Ukrelevetorprom. Zbiruk tez dopovideu 77 naukovoi konferentsii vukladachiv akademii. 2017. P.24-26.
9. Dmitrenko L.D., Kats A.K., Shpak V.M. Vidminnosti pruimannya zerna z avtotransportu na zagotivelnuh elevatorah i zernovuch terminalah. Zbiruk tez dopovideu 78 naukovoi konferentsii vukladachiv akademii. 2018. P.23-25.
10. Podgorodetskiu M.O. Tehnicheskoe reshenie konstruktsii ustroistv dlya razgruzki transportnuh sredstv. Hranenie I pererabotka zerna // Elektronniy resurs. Rezhim dostupu: https://hipzmag.com/tehnologii/hranenie/tehnicheskoe-reshenie-konstruktsii-ustrojstva-dlya-razgruzki-transportnyh-sredstv/

УДК: 338.246.8:341.38:[332.12:338.244.47](477.7)

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ДОСЛІДЖЕННЯ ХРОНОМЕТРАЖНИХ ХАРАКТЕРИСТИК ПРИЙМАННЯ ЗЕРНА З АВТОТРАНСПОРТУНА ЗАГОТВЕЛЬНИХ ЕЛЕВАТОРАХ

Анотація

На заготівельних елеваторах та хлібоприймальних підприємствах операція приймання зерна з автотранспорту є основною. Багато елеваторів інших типів також здійснюють приймання зерна з автотранспорту завдяки тому, що це дозволяє покращити економічні показники роботи підприємства та в загалі − комбінування функцій, притаманних елеваторам різних типів, є особливістю підприємств елеваторної галузі нашої країни. Практично для всіх елеваторів або зернових терміналів гостро стоїть питання автомобільних черг перед в'їздом. Впровадження різних високопродуктивних автомобілерозвантажувачів сприяє підвищенню пропускної спроможності елеваторів з розвантаження зерна з автомобілів і автопоїздів всіх видів. Процес приймання зерна з автотранспорту складається з декількох операцій, і кожна операція у цьому ланцюгу має важливе значення в скороченні часу перебування автомобіля на підприємстві, а отже, і збільшенні його пропускної здатності. Нами проаналізовано процес розвантажування автомобілів на автомобілерозвантажувачах У-15УРАГ-У, що встановлені на двох елеваторах Миколаївської та Житомирської областях. Здійснено хронометраж процесу вивантаження 20-ті одинарних автомобілів (тобто, без причепів), якими на підприємство було доставлено зерно. Виділено основні етапи вивантаження автомобілів у приймальних пристроях досліджуваних підприємств та визначені середній (найбільш достовірний), мінімальний та максимальний час виконання кожного етапу. Побудовано графіки хронометражу вивантаження автотранспорту з зерном пшениці на заготівельних елеваторах, де проводились дослідження. Результати хронометражу показали, що найбільш тривалим є етап підйому платформи автомобілерозвантажувача та висипання зерна, а найменш тривалим – вихід водія з кабіни. Середня тривалість розвантаження склала 561,5 с для першого підприємства (Миколаївська обл.) та 565 с для другого (Житомирська обл.). Слід зазначити, що час підняття та опускання платформ автомобілерозвантажувачів У15-УРАГ-У на обох розглянутих підприємствах відповідає паспортним даним, тобто вони працюють не з максимальною ефективністю.

Ключові слова: приймання зерна, приймальний пристрій, автомобілерозвантажувач, хронометраж.

Received 12.08.2022 **Revised 24.09.2022**
Reviewed 05.09.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Dmytrenko L., Sokolovskaya O., Valevskaya L. Study of time characteristics of grain receiving from auto transport at procurement elevators. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 6-11. **DOI** https://doi.org/10.15673/gpmf.v22i3.2455

Cite as State Standard of Ukraine 8302:2015
Study of time characteristics of grain receiving from auto transport at procurement elevators. / Dmytrenko L. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 6-11. **DOI** https://doi.org/10.15673/gpmf.v22i3.2455

UDC 636.
DOI https://doi.org/10.15673/gpmf.v22i3.2456
Alltech, https://www.alltech.com/
According to the materials of the Alltech company

GLOBAL FEED PRODUCTION REMAINS STEADY IN 2022

Pet feed shows most significant growth while reduction in beef feed production begins to moderate

An assessment of compound feed production and prices was conducted using information gathered by Alltech's global sales team in partnership with local feed associations.

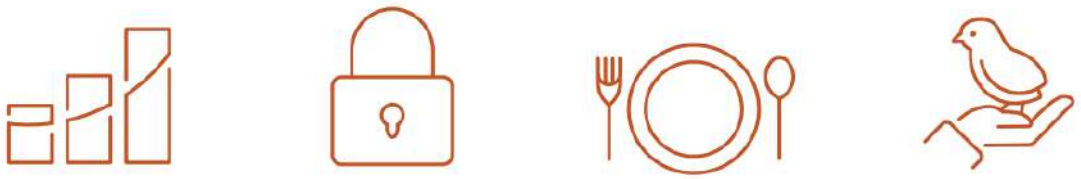
The Alltech Agri-Food Outlook also offers a holistic view of the state of the industry, using responses from our corresponding qualitative survey to identify trends and technologies impacting the agri-food industry, highlight growth opportunities and assess expectations for 2023.

The Alltech Agri-Food Outlook estimates global forage tonnage at 1.266 billion metric tons (BMT) in 2022, down less than half a percent from 2021. The study includes data from 142 countries and more than 28,000 feed mills.

Globally, increases in feed tonnage were reported in the aquaculture, broiler, layer and pet food sectors, while decreases were reported in the beef, dairy and pig sectors.

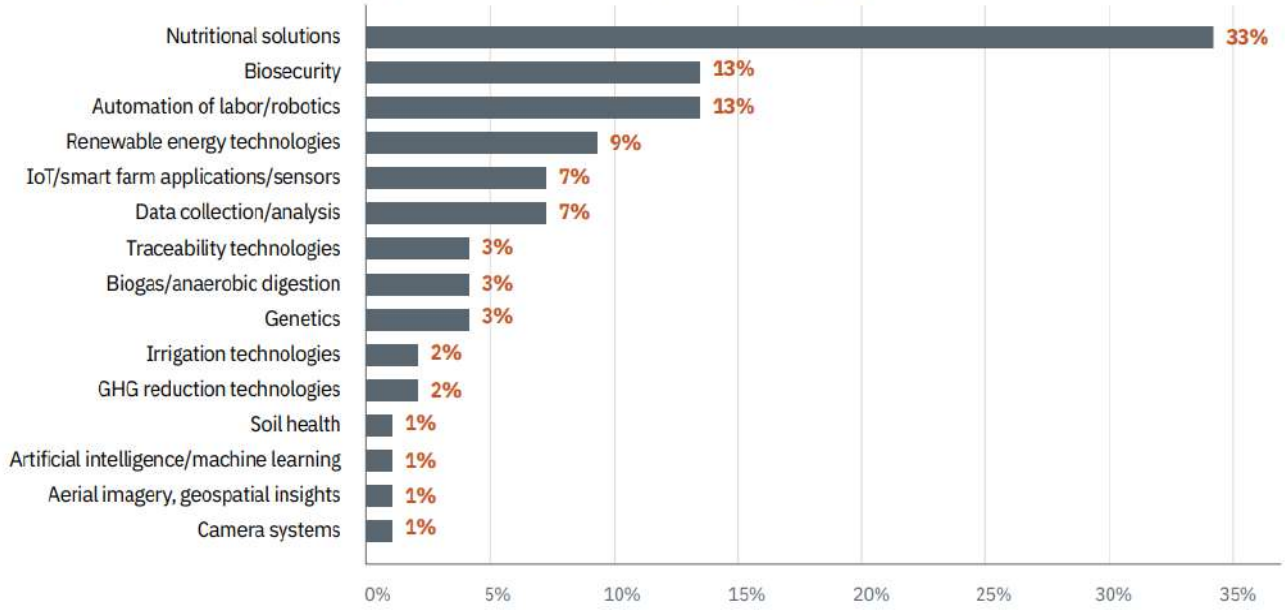
Although it experienced a narrow reduction in feed production, China remains the largest feed-producing country in the world, followed by the United States and Brazil.

Consumer trends making the biggest impact on agri-food



** 72% of Agri-Food Outlook respondents said product prices/the economy is the consumer trend that is making the biggest impact on the agri-food industry*

Technologies making the biggest impact
Survey respondents said these technologies are providing exciting opportunities for growth



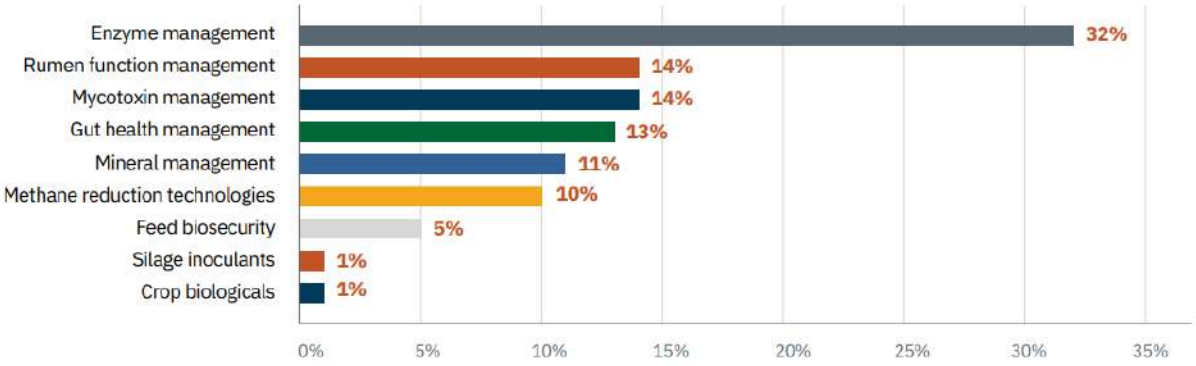
The role of technology

A variety of technologies are providing growth opportunities for the agri-food industry, survey respondents said. Among the technologies making the biggest impact are nutritional solutions, biosecurity and the automation of labor/robotics. Of nutritional solutions, respondents noted enzymes (32%), technologies impacting rumen function (14%) and the management of mycotoxins (14%) as being the most significant to their market. The use of enzymes to improve the digestibility of nutrients, decrease the cost of production and reduce the environmental impact of agriculture are having a significant positive impact, said one respondent from Spain. Innovative technologies that increase efficiency and improve sustainability were cited by many participants as being highly promising and important. "The biggest opportunities for growth are sustainable solutions for production costs, research and development for more durable and productive agricultural products [to mitigate] climate change, and new agricultural production technologies," said a respondent from Turkey.

Becoming more efficient with new-to-market technologies will improve profitability and help mitigate environmental impacts, a Canadian representative said.

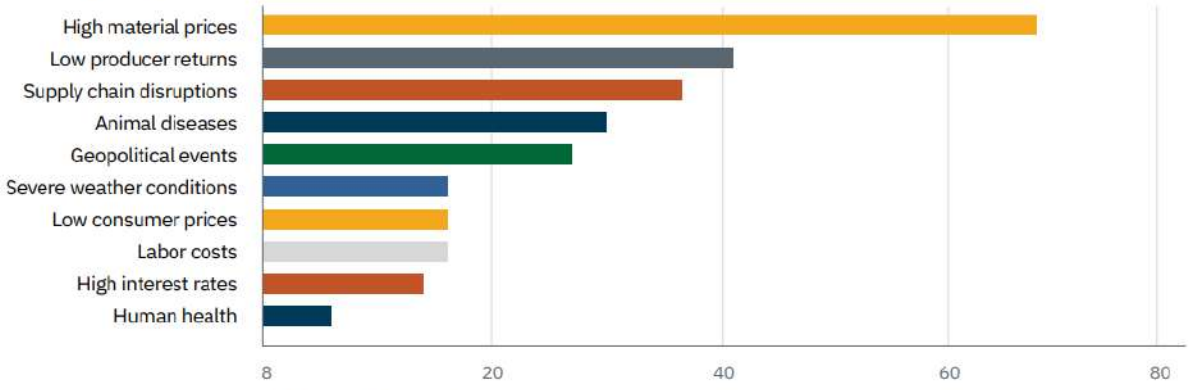
Top nutritional opportunities

Survey respondents said these nutritional solutions are most pertinent to feed production in their region



Top challenges to feed production*

Survey respondents identified the biggest ag-related challenges in their country

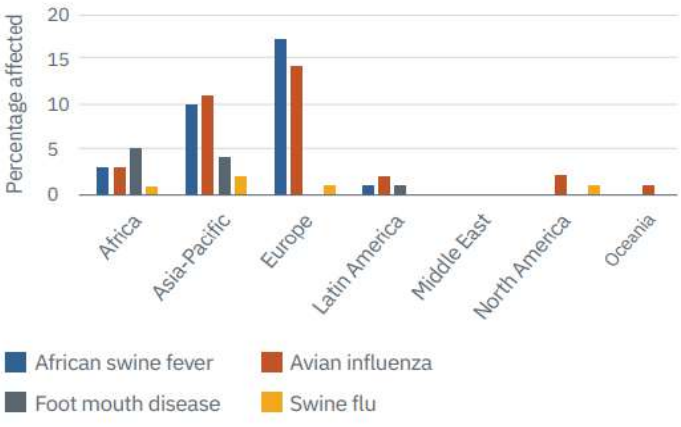


**Multiple choice question: Numbers indicate number of times the option was selected.*

Biggest challenges

Inflation and the overall state of the economy — particularly the increased prices of raw materials, feed and food — have been the biggest challenges affecting the agri-food sector in 2022, respondents said. The state of the economy will remain one of the biggest factors influencing the success of the industry, said a participant from South Africa. Changes in consumer habits such as point of purchase and dietary trends are also making an impact. "Due to the (COVID-19) epidemic, consumers' behavior has changed significantly and continuously, and they have taken a more proactive approach to health," said a survey respondent from

Diseases that impacted feed demand in 2022



China. Supply chain disruptions remain an obstacle for the agrifood industry across all regions. Many regions reported that geopolitical tensions — particularly the invasion of Ukraine — have affected imports and exports, the supply chain and raw materials prices. "The war in Ukraine has had a significant impact on raw material supplies across the region," said a survey participant from Belgium. The direct impact of the war was reported in Moldova and in Ukraine, where feed production fell by over 35%. The invasion of Ukraine also indirectly affected feed production throughout the rest of the world.

Disease disruptions

Animal diseases have disrupted feed production in more than 80% of countries. Avian influenza affected all regions' feed production in 2022. In Africa, this disease manifested most significantly in Egypt, Morocco and South Africa. In Asia, nearly all countries were affected. In Europe, the affected countries included Belgium, Bosnia and Herzegovina, Bulgaria, France, Ireland, Moldova, the Netherlands, Poland, Russia, Serbia, Turkey, the U.K. and Ukraine. In Europe, African swine fever (ASF) has most significantly affected Ireland and countries in the East. In the Americas, the Dominican Republic was affected most significantly. In Asia, ASF has played a significant role in China, Indonesia, Malaysia, Myanmar, Nepal, the Philippines, Singapore, South Korea, Thailand and Vietnam. In Africa, Kenya, Mozambique and Namibia were affected. Foot and mouth disease (FMD) was an issue in Africa, particularly in Egypt, Mozambique, Namibia and South Africa. In Asia, Indonesia, Mongolia, South Korea and Thailand were affected. Finally, in the Americas, FMD was an issue in Bolivia. Swine flu was an issue in Namibia, China, Myanmar, Belgium and the U.S. Overall, Latin America and the Middle East did not report many instances of disruption due to animal diseases.

Sustainability insights

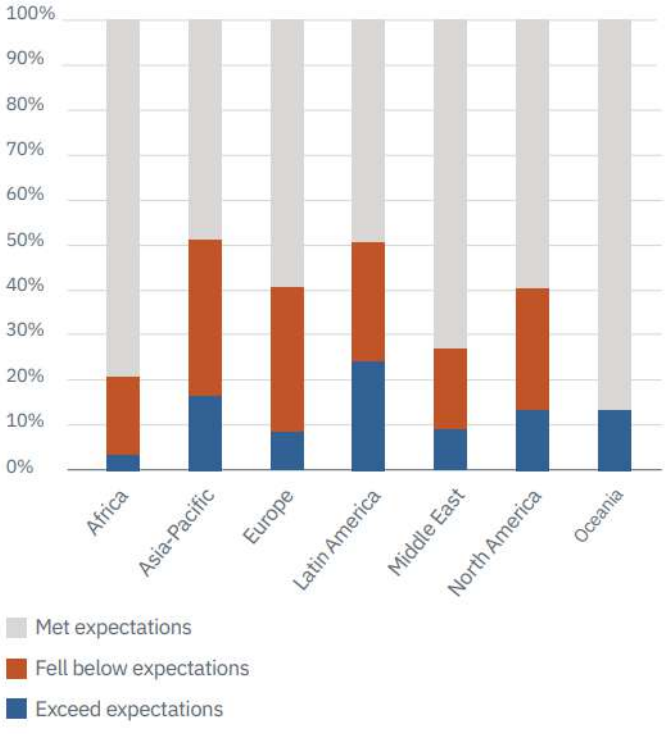
Efforts to improve environmental sustainability are impacting the feed/animal agriculture sector in most regions, survey respondents said. The majority of respondents said sustainability efforts are being driven by the government (50% of respondents), food producers and processors (47.27%), consumers (44.74%) and retailers/ food service companies (39.47%). The top sustainability measures being implemented include reducing antibiotic usage and antimicrobial resistance (AMR), improving animal welfare, producing food more efficiently, reducing water pollution, creating renewable energy, reducing greenhouse gas emissions, and enhancing nutritional value and food security. Survey respondents said that some of the biggest agrelated opportunities are new technologies like smart-farm applications, increasing efficiency, incorporating more nutritional solutions and continuing to make efforts to become more sustainable.

Feed tonnage by region

Based on data collected in November 2022, Alltech estimates that the total global feed tonnage in 2022 decreased slightly — by 5.381 million metric tons (MT), or 0.42% — to approximately 1.266 billion MT. The survey showed a 3.86% decrease in feed tonnage in Africa, mainly because of reductions reported in Egypt, Morocco, Kenya and Nigeria. South Africa, on the other hand, saw an increase of more than 2%, and Namibia also reported higher feed tonnage in 2022. The Asia-Pacific region was flat. Reductions in China, Pakistan, Thailand and Malaysia were offset by increases reported by Vietnam, the Philippines, Mongolia and South Korea. Despite the challenges faced there, Vietnam has been a growth market for feed in Asia. The biggest retreat in feed tonnage was seen in Europe, where it was down nearly 5%, or over 12 million metric tons (MMT). Some of the primary factors for this decreased production include the invasion in Ukraine and the spread of animal diseases, such as ASF and avian influenza. Among the big four regions, Latin America came out on top this year as the winner in terms of growth in feed tonnage, with an increase of over 3 MMT. Most of this growth was reported by Mexico, Brazil and Chile.

2022 expectations

59% of Alltech Agri-Food Outlook respondents said feed production in their region met their expectations



According to the materials of the Alltech company

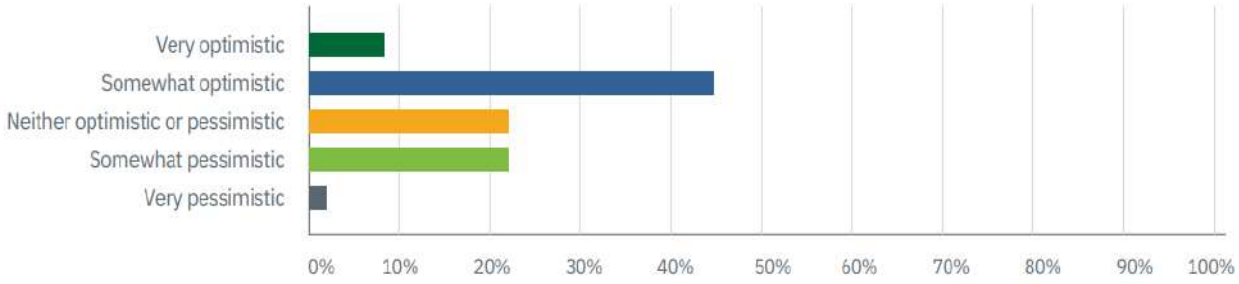
Region	Sum of 2021 total feed production (MMT*)	Sum of 2022 total feed production (MMT)	Growth (MMT)	Growth (%)
Africa	44.506	42.788	-1.718	-3.86%
Asia-Pacific	467.922	465.540	-2.382	-0.51%
Europe	276.114	263.232	-12.882	-4.67%
Latin America	187.904	190.910	3.006	1.6%
Middle East	25.484	31.785	6.301	24.73%
North America	259.367	261.639	2.272	0.88%
Oceania	10.433	10.466	0.033	0.32%
Grand Total	**1,271.731**	**1,266.350**	**(5.381)**	**-0.42%**

**Million metric tons*
***Latin America includes all Central American countries, including Mexico*
****North America includes Canada and the U.S.*

The Middle East region is also up significantly, as a result of more accurate reporting and efforts by the Saudi Arabian government to increase broiler production as part of its Vision 2030 plan. North America (the U.S. and Canada) reported an increase of more than 2.4 MMT (all in the U.S.). Growth was reported in the broiler, beef and pet food sectors. The region of Oceania was flat, with a small reduction reported by Australia that was offset by a slight increase reported by New Zealand. The majority of respondents, 59%, said that feed production in their country met their expectations in 2022. Feed tonnage fell below expectations for 28% of survey respondents and exceeded expectations for 13%. Looking ahead, over half of respondents (52.5%) said they are optimistic that feed production in their country will grow in 2023.

Outlook for 2023

Over half of respondents said they are optimistic that feed production will grow in 2023



Feed production estimates by sector

Globally, feed tonnage increased in the broiler, layer, aquaculture and pet food sectors. Volume growth in feed tonnage came predominantly from the broiler feed sector.

Percentage wise, the biggest growth was in pet food. The pig, dairy and beef sector experienced decreased feed tonnage.

Sector	2021 feed tonnage (MMT*)	2022 feed tonnage (MMT)	Growth (MMT)	Growth %
Broiler	359.387	363.960	4.573	1.27%
Pig	329.185	319.383	(9.802)	-2.98%
Layer	161.356	161.849	0.493	0.31%
Dairy	135.616	133.823	(1.793)	-1.32%
Beef	118.441	118.042	(0.399)	-0.34%
Aqua	51.510	52.914	1.403	2.72%
Pets	32.884	35.270	2.430	7.25%
Equine	8.091	8.159	0.068	0.83%
Grand Totals*	**1,271.731**	**1,266.350**	**(5.381)**	**-0.42%**

*Million metric tons
**Grand total includes listed species as well as calf, other ruminants, turkeys, other poultry and other species.

**According to the materials of the Alltech company, 2022*

A closer look at the top 3 countries

China

- Overall feed production dropped by nearly 3%
- Pig feed dropped by 5%
- Broiler feed production was down 3%
- Layer feed production decreased by 3%
- **On the upside:** China reported a 10% (2 MMT) increase in feed tonnage for aquaculture
- **Tech:** Artificial intelligence/machine learning is making the biggest impact on agriculture, according to the survey
- **Consumer trends:** Changes in eating habits for environmental and health reasons are the biggest consumer trend affecting agriculture in China, the survey found
- **Challenges:** High ingredient prices, low producer returns, supply chain disruptions, animal diseases, geopolitical events
- **Outlook:** Somewhat pessimistic that feed production will grow in 2023

United States

- Overall production was up 1.02%
- Pet feed grew by 6.12%
- Broiler feed production rose by 3.5%
- Layer feed increased 3%
- Aquaculture feed was up 2.15%
- Beef feed grew by nearly 1%, and equine was up 0.67%
- **Tech:** Biosecurity measures are making the biggest impact on agriculture
- **Consumer trends:** Product prices/the economy are the number-one consumer trend affecting the industry
- **Challenges:** High material prices, low producer returns, supply chain disruptions
- **Outlook:** Somewhat optimistic that feed production will grow in 2023

Brazil

- Overall feed production was up 0.87%
- Dairy feed tonnage was down 3%
- Beef feed tonnage was up 3%
- Layer tonnage decreased 4%
- Broiler feed tonnage increased 1%
- **Tech:** Data collection and analysis is the technology making the most impact on agriculture.
- **Consumer trends:** Product prices/ economy was the biggest consumer trend affecting the industry.
- **Challenges:** Supply chain disruptions, severe weather conditions, geopolitical events
- **Outlook:** Somewhat optimistic that feed production will grow in 2023.

Feed production estimates by sector

AGRI-FOOD OBSERVATIONS

Survey respondents said the **top 3 technologies** making the most impact on agri-food are:

- Nutritional solutions, 33%
- Biosecurity, 13%
- Automation of labor/robots, 13%

Globally, feed tonnage increased in the broiler, layer, aquaculture and pet food sectors. Volume growth in feed tonnage came predominantly from the broiler feed sector. Percentage wise, the biggest growth was in pet food. The pig, dairy and beef sector experienced decreased feed tonnage.

The broiler sector had the highest global feed production, with nearly 364 million metric tons.

In areas affected by avian influenza, the availability of breeding poultry was limited, limiting the growth and expansion of production. Disease, macroeconomic difficulties and prolonged periods of high production costs limit poultry growth worldwide.

In total, we saw about 1.32% less compound feed produced in the global dairy sector.

**According to the materials of the Alltech company, 2022*

Region	2021 broiler feed tonnage (MMT*)	2022 broiler feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	13.956	13.126	(0.830)	-5.95%
Asia-Pacific	153.404	153.532	0.128	0.08%
Europe	54.938	54.169	(0.769)	-1.40%
Latin America	66.717	67.561	0.845	1.27%
Middle East	8.217	11.401	3.184	38.75%
North America	58.200	60.132	1.932	3.32%
Oceania	3.956	4.039	0.083	2.10%
Grand Total	**359.387**	**363.960**	**4.573**	**1.27%**

Region	2021 layer feed tonnage (MMT*)	2022 layer feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	9.545	9.224	(0.321)	-3.36%
Asia-Pacific	76.481	75.940	(0.541)	-0.71%
Europe	30.988	30.672	(0.316)	-1.02%
Latin America	23.629	24.506	0.877	3.71%
Middle East	4.621	4.977	0.356	7.70%
North America	15.120	15.530	0.410	2.71%
Oceania	0.972	1.001	0.029	2.98%
Grand Total	**161.356**	**161.849**	**0.493**	**0.31%**

Region	Sum of 2021 pig feed tonnage (MMT*)	Sum of 2022 pig feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	3.319	3.317	(0.002)	-0.05%
Asia-Pacific	143.537	140.377	(3.159)	-2.20%
Europe	81.871	75.117	(6.754)	-8.25%
Latin America	35.450	36.167	0.717	2.02%
Middle East	0.007	0.007	0.000	0.50%
North America	63.600	62.984	(0.616)	-0.97%
Oceania	1.401	1.414	0.013	0.93%
Grand Total	**322.266**	**319.383**	**(9.802)**	**-2.98%**

Region	Sum of 2021 dairy feed tonnage (MMT*)	Sum of 2022 dairy feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	5.580	5.071	(0.509)	-9.12%
Asia-Pacific	24.136	24.154	0.018	0.07%
Europe	43.416	42.199	(1.217)	-2.80%
Latin America	25.738	25.461	(0.277)	-1.08%
Middle East	6.528	6.992	0.464	7.11%
North America	28.700	28.500	(0.200)	-0.70%
Oceania	1.518	1.446	(0.072)	-4.74%
Grand Total	**135.616**	**133.823**	**(1.793)**	**-1.32%**

**Million metric tons*

**According to the materials of the Alltech company, 2022*

Region	Sum of 2021 beef feed tonnage (MMT*)	Sum of 2022 beef feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	2.479	2.575	0.095	3.84%
Asia-Pacific	13.810	14.279	0.469	3.40%
Europe	17.542	15.765	(1.776)	-10.13%
Latin America	15.642	16.015	0.373	2.39%
Middle East	1.456	1.556	0.100	6.89%
North America	66.772	67.355	0.429	0.64%
Oceania	0.740	0.650	(0.090)	-12.16%
Grand Total	**118.441**	**118.042**	**(0.399)**	**-0.34%**

Region	Sum of 2021 aqua feed tonnage (MMT*)	Sum of 2022 aqua feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	1.484	1.449	(0.035)	-2.38%
Asia-Pacific	37.350	38.340	0.990	2.65%
Europe	4.605	4.687	0.082	1.78%
Latin America	5.652	5.922	0.271	4.79%
Middle East	0.500	0.566	0.066	13.14%
North America	1.730	1.750	0.020	1.16%
Oceania	0.190	0.200	0.010	5.26%
Grand Total	**51.510**	**52.914**	**1.403**	**2.72%**

Region	Sum of 2021 pet feed tonnage (MMT*)	Sum of 2022 pet feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	0.454	0.342	(0.111)	-24.57%
Asia-Pacific	2.267	2.478	0.212	9.33%
Europe	11.587	11.778	0.191	1.65%
Latin America	7.434	8.863	1.429	19.22%
Middle East	0.090	0.106	0.016	17.25%
North America	10.600	11.200	0.600	5.66%
Oceania	0.452	0.502	0.050	11.06%
Grand Total	**32.884**	**35.27**	**2.386**	**7.25%**

Region	Sum of 2021 equine feed tonnage (MMT*)	Sum of 2022 equine feed tonnage (MMT)	Growth (MMT)	Growth %
Africa	0.078	0.079	0.001	1.25%
Asia-Pacific	0.494	0.536	0.042	8.51%
Europe	2.129	2.152	0.023	1.09%
Latin America	1.093	1.043	(0.050)	-4.54%
Middle East	0.137	0.139	0.002	1.47%
North America	3.778	3.800	0.022	0.58%
Oceania	0.383	0.410	0.027	7.05%
Grand Total	**8.091**	**8.159**	**0.068**	**0.83%**

**Million metric tons*

**According to the materials of the Alltech company, 2022*

Cite as Vancouver Citation Style
Global feed production remains steady in 2022. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 12-18.
DOI https://doi.org/10.15673/gpmf.v22i3.2456
Cite as State Standard of Ukraine 8302:2015
Global feed production remains steady in 2022// Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 12-18.
DOI https://doi.org/10.15673/gpmf.v22i3.2456

DOI https://doi.org/10.15673/gpmf.v22i3.2457

NEW EDUCATIONAL AND SCIENTIFIC LABORATORIES - NEW OPPORTUNITIES!

By the 120th anniversary of Odesa National Technological University on October 20, 2022, the opening of a modern Educational and Scientific Laboratory for determining the quality of grain, fodder raw materials and compound fodder is planned on the basis of the department of grain and compound feed technology.

Significant organizational and repair work was carried out together with the partners of the university. The laboratory was created with the assistance of the company ADM ("Archer Daniels Midland") LLC "Ukrelevatorprom" and the funds were received from the joint participation of the company and the department of grain and compound feed technology of ONTU in STEM grants (science, technology, engineering, mathematics).

Within the framework of the won grant, modern laboratory equipment of the company VELP Scientifica Srl was purchased with the support of SOCTRADE LLC. (Italy) in the amount of over UAH 757,000: VELP Scientifica Srl analyzer (DK 6+SMS+JPm+UDK 129) for protein determination by the Kjeldahl method, including steam distillation, titration and analysis; semi-automatic fat extractor SER 148/3 for 3 positions of simultaneous determination of fat, which works according to Randall's method (hot extraction when the sample is in a boiling solvent); FIWE3 analyzer for 3 positions of simultaneous determination of fiber, as well as a low-temperature laboratory electric oven (drying cabinet) SNOL67/350 (Lithuania) is intended for analytical work, drying of various materials, normalization and relaxation of metal, springs, heat treatment of plastics and other materials in an air environment stationary conditions at temperatures from +50 to +350°C.

The laboratory also allows you to evaluate the physical properties of raw materials and finished products, conduct express research and analyze wheat grain, cereal products (compound feed, groats, flour) using the Spektran-119M device, which works in the

infrared spectrum, which determines the mass of grain and oil crops share of moisture, fiber, protein, ash; photocolorimetric studies using a KFK-2 MP photocolorimeter to measure transmission coefficients, optical density of transparent liquid solutions and transparent solid samples, as well as to determine the concentration of substances in solutions and the rate of change of the optical density of a substance, etc.

The equipment of the laboratory is as close as possible to production laboratories, all samples of raw materials and finished products received for testing are examined for compliance with the latest requirements of DSTU, regulations and directives of the EU and other NDs.

A special highlight of the laboratory is a unique collection of feed raw materials, feed additives, biologically active substances and finished products, which includes about 150 samples.

The management of Odesa National University of Technology highly appreciates the contribution of ADM LLC "Ukrelevatorprom" to the educational process of our students and is confident in the development of further partnership relations in the field of training qualified and conscientious specialists, since a large proportion of the company's employees are graduates of ONTU.

The department of technology of grain and compound feed invites specialized enterprises of the grain processing industry to cooperate.

A. Makarynska, Doctor of Technical Sciences, Associate Professor

Revised 24.09.2022. Approved 04.10.2022

UDC 636.087.7-021.465:[665.117:665.347.8]
DOI https://doi.org/10.15673/gpmf.v22i3.2458

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ASSESSMENT OF HIGH-PROTEIN QUALITY FEED ADDITIVES FROM BY-PRODUCTS MANUFACTURE OF SUNFLOWER OIL

Abstract

The article states that until 2022, Ukraine will occupy the first place in the world food market in the production of sunflower, sunflower oil and export of sunflower oil. The production of sunflower has always been sufficiently profitable, and the products of its processing competitive on the domestic and world markets. They are also an important component of food and feed protein resources. The production of complete ration compound feed for farm animals and poultry is restrained by a shortage of protein components, a low level of sanitary and hygienic safety of protein raw materials of animal origin. This leads to a decrease in the efficiency of feed, their costs and, as it should be, a shortage of livestock products. Cake and meal are high-protein raw materials, which are obtained in the amount of 1/3 of the mass of processed seeds during the production of sunflower oil. The fodder value of sunflower cake and meal is given. Factors that negatively affect the nutritional value and availability of nutrients of sunflower meal in the feed of farm animals and poultry were analyzed. The choice of components for the production of high-protein feed additive is theoretically justified. The indicators of the quality of sunflower seeds and by-products of their processing, which meet the requirements of DSTU, have been determined. On the basis of theoretical and experimental data, a structural scheme for the production of a high-protein feed supplement based on sunflower cake and meal is proposed, which involves the preliminary preparation of the by-products of sunflower oil production - cake and meal, with the following dosage in the amount: 75% sunflower meal, 10% sunflower cake and 15% limestone flour. The physical properties and microbiological indicators of the quality of a high-protein feed additive were experimentally determined, and it was determined that, compared to a loose, granular high-protein feed additive, it has the following advantages: increased nutritional value, has a greater volumetric weight, sanitary quality, which leads to saving space during transportation and better storage.

Key words: feed additive, sunflower meal, sunflower cake, limestone flour, quality, granulation, physical properties, microbiological indicators, farm animals.

Introduction

In the agro-industrial complex of Ukraine, the oil and fat branch of the food industry occupies a leading place. Oilseed processing enterprises produce oil and fatty products for food, technical and fodder purposes, including strategic ones. It is known that vegetable oil is a source of energy and contains a number of essential nutrients, in particular unsaturated fatty acids.

Until 2022, Ukraine took first place in the world food market in terms of sunflower, sunflower oil and

sunflower oil exports. Sunflower production has always been sufficiently profitable, the products of its processing competitive on the domestic and world markets. They are also an important component of food and feed protein resources. [1]

During the production of sunflower oil, up to 36% of the mass of processed seeds is obtained by by-products - cake and meal. It is known that the by-products contain all the components of the nutritive value of the seed, with the exception of crude fat, which is reduced to 8-17% in the pulp and 2% in the meal. Cake and meal are high-protein feed for animals. The high feed value is due to the content of certain essential amino acids, calcium and phosphorus, vitamins of group E and group B. [2,3]

On average, sunflower cake contains: protein - 39.6%, fat - 1.6%, crude fiber - 12.3%, BER - 23.5%, ash - 6.0%. There are slightly more essential amino acids than in meal. Cake, like meal, is fed as part of compound feed, feed mixes and separately. Feed conversion is 3-5 kg/kg. [2,4]

However, there are factors that negatively affect the nutritional value and availability of nutrients of sunflower meal in the feed of farm animals and poultry [5]:

• increased crude fiber content of 12-18%, which leads to swelling and retention of feed in the intestinal tract, which can be a problem for young farm animals and poultry;

• a large number of non-starchy polysaccharides (up to 40%), which animals are unable to digest due to a lack of appropriate enzymes;

• the content of chlorogenic and quinic acids, the level of which is 1.56 and 0.48%, respectively, the negative effect of which is manifested in the inhibition of digestive enzymes of the gastrointestinal tract, and accordingly affects the digestibility of protein and the assimilation of the amino acids lysine and methionine;

• deficiency of such an important amino acid as lysine, which requires additional inclusion of a synthetic drug;

• low resistance to oxidation.

One of the most important problems with long-term storage of cakes is the deterioration of quality indicators. The cake turns rancid quickly due to the presence of residual amounts of fatty acids, and as humidity increases, the destruction of nutrients increases. The critical moisture level for cake is 8-10%. The low resistance of lipids to oxidation, especially those containing unsaturated fatty acids, leads to the accumulation of peroxides, hydroxy acids, ketones, aldehydes, which have a toxic effect on the body of farm animals and poultry.

To ensure the stability of cakes before storage, the level of fat content is reduced. However, in recent years, the production of sunflower cake with a higher fat content is increasingly being practiced to ensure the energy needs of farm animals and poultry, as well as to avoid the additional introduction of fats during the production of compound feed.

Along with the problem of improving cake quality indicators, calcium imbalance is a big problem for poultry farming, namely calcium deficiency in laying hens during the ovulation period. All this determines the need to include mineral raw materials in the composition of the feed additive.

Limestone flour is characterized by low cost and high calcium content, which is why it has gained such popularity among other mineral raw materials. In addition, limestone flour has adsorption properties, allows you to increase the percentage of cake application, reduces the cost of raw materials, which is an important factor in the calculation of compound feed recipes for poultry. [6]

A high-protein feed additive based on the by-products of sunflower oil production has been developed, which can be used for feeding farm animals and poultry.

The scheme of the technological process of the production of a high-protein feed additive consists of the following lines: [7]

– Line for cleaning oilseeds;
– The line of falling oilseeds;
– Line for pressing kernels of oilseeds;
– Cake and meal preparation line;
– Dosing line;
– Mixing line;
– Granulation line.

The purpose of the study

The purpose of the work is to study the quality indicators of a high-protein feed additive from the by-products of sunflower oil production.

Results and its discussion

Screening showed that sunflower seed processing yields about 41% sunflower oil, 33% cake and 26% husk. [7]

Table 1 shows the quality indicators of sunflower seeds and the quality indicators of the by-products of its processing - cake and meal.

Table 1 – Quality indicators of sunflower seeds and by-products of their processing

Indexes	Sunflower seeds		Sunflower cake		Sunflower meal	
	research	DSTU 7011:2009	research	DSTU 8096	research	DSTU 11246-96
Humidity, no more than %	6,8	8	4,4	8,5	8,9	10
Crude protein, not less than %	14,8	–	36,2	38	34,7	39
Crude fiber, not more than %	–	–	17,4	20	19,2	23
Crude fat, no more than %	45,2	–	19,7	6	0,95	1
Acid number, no more than %	1,6	2,2	–	–	–	–
Oleic acid, %	85,7	–	–	–	–	–

Table 2 – Physical properties of components for the production of high-protein feed additive

Indexes	Sunflower meal	Sunflower cake	Limestone flour
Nature, kg/m^3	458	1028	1416
Flowability, cm/s	12,9	2,2	0,9
Angle of natural slope, degree.	37	42	45
Mass fraction of moisture, %	8,9	4,4	0,4

The physical properties of the components for the production of a high-protein feed additive were determined experimentally (Table 2).

As a result of the obtained data, it can be concluded that the meal is characterized by low nature and high flowability, and the cake, due to the high fat content, has low flowability.

According to the studies, the determination of the coefficient of variation in the distribution of limestone flour and the coefficient of variation in the distribution of sunflower cake showed that the most effective additive is mixed, which includes 75% sunflower meal, 10% sunflower cake and 15% limestone flour. [8]

On the basis of theoretical and experimental data, a structural scheme for the production of a high-protein feed supplement based on cake and meal is proposed (Fig. 1), which provides for the preliminary preparation of the by-products of sunflower oil production - cake and meal, with the following dosing in the amount: 75% sunflower meal, 10 % sunflower cake and 15% limestone flour.

The dosed components of the high-protein feed additive are mixed in a batch mixer, as a result, a loose high-protein feed additive is obtained, which is sent for granulation in a press-granulator. The resulting granules are sent to a cooler for cooling to a temperature no higher 10 °C of the environment.

By analyzing the physical properties of raw materials and finished products, it is possible to judge the degree of their freshness and suitability for further consumption. The finished products were evaluated according to such physical properties as appearance, color, smell, particle size, angle of natural slope, moisture, flowability, nature.

The organoleptic and physical properties of the loose and granular high-protein feed additive were determined experimentally (Table 3).

The bulk feed additive has the following disadvantages - it is hygroscopic and has a small volumetric mass. During its transportation, storage and use, self-sorting, sawing, clumping will be observed. To eliminate these shortcomings, save and rationally use the high-energy additive for the production of compound feed, it is necessary to produce it in a compressed form in the form of granules. Compared to the loose, granular additive has the following advantages: increased nutritional value, sanitary quality, better storage, has a larger volumetric mass, which leads to saving space during transportation and storage.

Table 3 – Physico-mechanical parameters of the high-protein feed supplement

Indexes	High-protein feed additive	
	loose	granulated
Appearance	homogeneous loose mass	granules
Color	different shades of gray	
Scent	characteristic of sunflower meal and cake without extraneous smell	
Mass fraction of moisture,%	9,4	9,1
Flowability, cm/s	4,3	7,7
Angle of natural slope, degree.	48	39-
Nature, kg/m^3	446	865
L/D ratio	–	2,6
Water resistance, min.	–	7
Water absorption coefficient, %	–	1,05
Fragility, %	–	7,4

All compound feed products must meet the requirements of veterinary and sanitary standards. It is known that microorganisms are the main reason for the deterioration of the quality indicators of compound feed products. In this regard, it is necessary to have a clear idea of the microflora of the additive and to know how the production methods and storage conditions of the manufactured products affect it.

We determined the effect of heat treatment (granulation) on the change in the microbiota of a high-protein feed supplement, which was produced according to the developed recipe [8] and improved technology [7].

In the experimental samples, the following were determined:

- the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFAnM), CFU in 1 g of product;
- the presence of mold fungi in 1 g of the product;
- the presence of Escherichia coli bacteria (E. coli) in 0.1 g of the product;
- the presence of bacteria of the paratyphoid group (salmonella), in 25 g of the product;
- presence of Pr. vulgaris in 0.1 g of the product;
- the presence of Staphylococcus aureus.

The results of research on the determination of microbial contamination of loose and granular high-protein feed additives are shown in Table 4.

The study of microbiological indicators of the quality of loose and granular high-protein feed additives was carried out using the experimental base of the Department of Biochemistry, Microbiology and Physiology of Nutrition of ONTU. The mass fraction of moisture of the granulated additive was 9.2%, the amount of MAFAnM - 7*105 CFU/g, mycelial fungi - 17 CFU/g, pathogenic forms of Salmonella and Staphylococcus aureus were not detected.

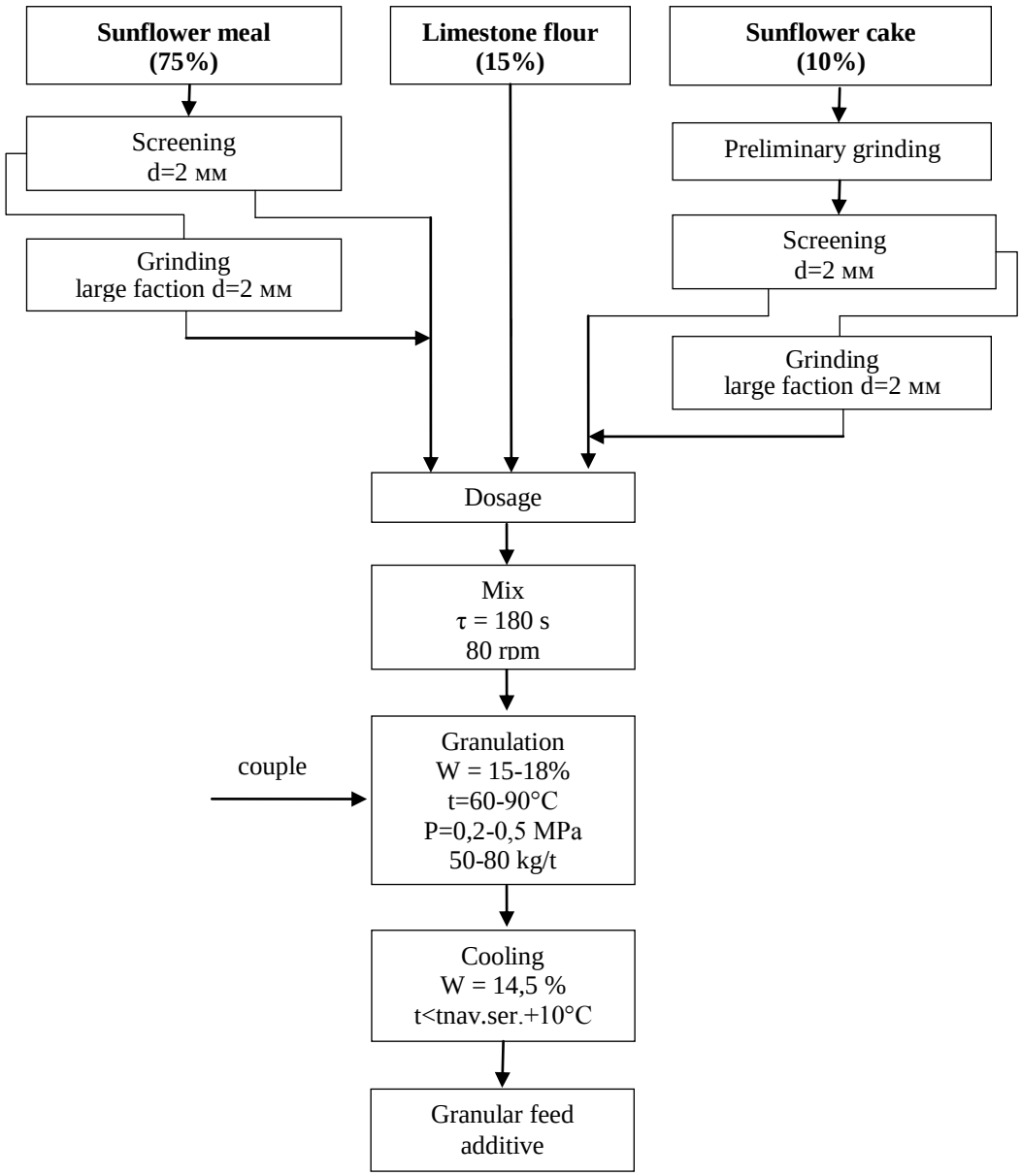

Fig. 1 – Functional diagram of the production of a high-protein feed supplement based on the by-products of sunflower oil production

Table 4 – Study of microbiological indicators of the quality of a high-protein feed supplement (n=3, P≥0.95)

Indexes	High-protein feed additive		Зміни, %
	loose	granulated	
MAFAnM (CUO/1g)	$1{,}3\times10^6$	$0{,}7\times10^6$	47
Mycelial mushrooms, CFU/1 g	55	17	70
BGKP title, g	not found	not found	–
Salmonella	not found	not found	–
Proteus vulgaris	found	not found	100
Staphylococcus aureus	not found	not found	–

As a regulation of the quantitative and qualitative composition of microorganisms, the norms for sunflower meal were adopted, that is, the total number of microorganisms should not exceed 1.5×106 CFU/g [9].

Research analysis shows that as a result of granulation, microbial contamination of the additive decreased by 47% according to the MAFAnM indicator, and mycelial fungi by 70%. Granulation made it possible to get rid of Proteus vulgaris, which had contaminated the bulk feed additive. Thus, the effect of high temperature allows to ensure a significant degree of reduction of the microflora of the additive.

Conclusions

The physical properties and microbiological indicators of the quality of the high-protein feed additive show that, compared to the loose, granular high-protein feed additive, it has the following advantages: increased nutritional value, has a greater volumetric weight, a smaller amount of MAFAnM and mycelial fungi, which leads to saving space during transportation and better storage.

REFERENCES

1. Agravery [Веб-сайт]. - URL: https://agravery.com/uk/posts/show/ukraina-zalisitsa-svitovim-liderom-iz-virobnictva-ta-eksportu-sonasnikovoi-olii-ekspert (дата звернення: 20.04.2022)
2. Peshuk l.v L. V., Nosenko T. T. Biokhimiya ta tekhnolohiya oliye-zhirovoyi sirovini: navch. posib. Kiyiv: TSUL, 2011. 296 s.
3. Raes K, De Smet S, Demeyer D. Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review. Animal Feed Science and Technology 2004. 113: 199–221.
4. Sunflower, virgin-olive and fish oils differentially effect the progression of aortic lesions in rabbits with experimental atherosclerosis / C. M. Aguilera, M. C. Ramirez-Tortosa, M. D. Mesa [et al.] // Atherosclerosis (КЭ). 2002. 162, № 2. P. 335–344.
5. Fijalovych, L., Kyryliv, Y., & Paskevych, G. (2019). Features of providing broiler chickens with exchange energy and protein as important indicators of productivity and quality of the obtained products. Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences, 21(91), 60-64. https://doi.org/10.32718/nvlvet-a9110
6. Iegorov B., Kananykhina O., Turpurova T. Probiotic feed additives in fattening of agricultural animals. Grain Products and Mixed Fodder's, 2021; 21 (4, 84): 25-31. DOI https://doi.org/10.15673/gpmf.v21i4.2250
7. Iegorov B., Kananykhina O., Turpurova T. Development of production technology of high-protein feed additive from by-products of sunflower oil production. Grain Products and Mixed Fodder's, 2022; 22 (2, 86): 17-23. DOI https://doi.org/10.15673/gpmf.v22i2.2442
8. Yegorov, B., Turpurova, T., Sharabaeva, E., & Bondar, Y. (2019). Prospects of using by-products of sunflower oil production in compound feed industry. Journal of Food Science Technology Ukraine, 13, 106–113. doi: 10.15673/fst.v13i1.1337
9. Nalivayko L. I., Bezrukava I. Yu., Bondarenko A. L. Sanitarno-mikrobiolohichna otsinka kormiv // Ptakhivnitstvo: Mizhvid. temat. nauk. zb. / IP UAAN. Birki, 2008.# 61. S. 90-94.

УДК 636.087.7-021.465:[665.117:665.347.8]

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ОЦІНКА ЯКОСТІ ВИСОКОБІЛКОВОЇ КОРМОВОЇ ДОБАВКИ З ПОБІЧНИХ ПРОДУКТІВ ВИРОБНИЦТВА СОНЯШНИКОВОЇ ОЛІЇ

Анотація

У статті зазначено, що Україна до 2022 року займала перше місце на світовому ринку продовольства за виробництвом соняшника, соняшникової олії та експорту соняшникової олії. Виробництво соняшнику завжди було достатньо рентабельним, а продукти його переробки конкурентоспроможними на внутрішньому і світовому ринках. Вони також є важливою складовою продовольчих і кормових білкових ресурсів. Виробництво повнораціонних комбікормів для сільськогосподарських тварин і птиці стримується дефіцитом білкових компонентів, низьким рівнем санітарної та гігієнічної безпеки білкової сировини тваринного походження. Це призводить до зниження ефективності кормів, їхнім витратами та, як слід, недоотримання тваринницької продукції. Макуха та шрот – високобілкова сировина, яку отримують в кількості 1/3 від маси переробленого насіння при виробництві соняшникової олії. Наведено кормову цінність соняшникової макухи та шроту. Проаналізовано фактори, які негативно впливають на поживну цінність та доступність поживних речовин соняшникового шроту у годівлі сільськогосподарських тварин та птиці. Теоретично обґрунтовано вибір компонентів для виробництва високобілкової кормової добавки. Визначено показники якості насіння соняшника та побічних продуктів його переробки, що відповідають вимогам ДСТУ. На основі теоретичних та експериментальних даних запропоновано структурну схему виробництва високобілкової кормової добавки на основі соняшникової макухи та шроту, яка передбачає попередню підготовку побічних продуктів виробництва соняшникової олії – макухи та шротів, з наступним дозуванням в кількості: 75 % соняшникового шроту, 10 % соняшникової макухи та 15 % вапнякової муки. Експериментально визначено фізичні властивості та мікробіологічні показники якості високобілкової кормової добавки, визначено, що в порівнянні з розсипною, гранульована високобілкова кормова добавка має наступні переваги: підвищену поживну цінність, має більшу об'ємну масу, санітарну якість, а саме кількість МАФАнМ та мікроміцетів, що призводить до економії площ при транспортуванні і кращого зберігання.

Ключові слова: кормова добавка, соняшниковий шрот, соняшникова макуха, вапнякова мука, якість, гранулювання, фізичні властивості, мікробіологічні показники, сільськогосподарські тварини.

Received 31.08.2022 **Revised 27.09.2022**
Reviewed 16.09.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Yegorov B., Kananykhina O., Turpurova T. Assessment of high-protein quality feed additives from by-products manufacture of sunflower oil. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 20-24. **DOI** https://doi.org/10.15673/gpmf.v22i3.2458

Cite as State Standard of Ukraine 8302:2015
Assessment of high-protein quality feed additives from by-products manufacture of sunflower oil. / Yegorov B. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 20-24. **DOI** https://doi.org/10.15673/gpmf.v22i3.2458

UDC 637.54:658.628:005.52
DOI https://doi.org/10.15673/gpmf.v22i3.2459

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ANALYSIS OF THE POULTRY MEAT MARKET AND JUSTIFICATION OF EXPANDING ITS RANGE

Abstract

Based on marketing research, it has been proven that a third of consumers in the world prefer poultry meat. It is established that the investment attractiveness of the poultry business, the construction of modern large poultry farms and the creation of powerful vertically integrated companies are due to the speed of return on capital investments and the high profitability of the industry. In order to determine the position of Ukraine on the world market, the rating of 45 countries by the level of consumption and production of poultry meat in 2021 was summarized. The traditional leaders in the production and consumption of meat products are the USA, Brazil and China. Ukraine ranks 21st in terms of production and 23rd in consumption of poultry meat. Most countries have a shortage of meat products and can be potential buyers of Ukrainian meat. Ukraine has all the opportunities and prospects for expanding the export of its own products. It is justified that duck farming is one of the modern dynamic areas of poultry farming and a competitive type of agribusiness, as evidenced by its dynamic development. The perspective and dynamism of this poultry farming area is determined by the high fertility and precociousness of poultry. Duck meat markets are not monopolized by large industrial players, which makes it possible to diversify business and avoid excessive competitive pressure. Export opportunities of niche meat producers to EU countries are significantly inferior in terms of volumes to traditional chicken meat, but this market is distinguished by its ability to pay. Ukraine is one of the largest producers of duck meat in Europe. On a global scale, the duck market is 5% of the chicken market. The low level of duck meat production in the world (except Asia) is explained by the seasonality of consumption. The priority task of the development of duck farming in Ukraine is the protection of the domestic market and the development of the export of products to world markets. Industrial production of duck meat in Ukraine should focus on export to Asian and European countries, where this product is in greater demand than at home. It is established that with proper organization the business of raising ducks is economically feasible and practically waste-free. The main products of production are meat, eggs, down and feathers, droppings and duck liver.

Key words: ducks, complete feeds, poultry meat, industrial producers, world consumption and production, niche types of meat products.

Introduction

According to the UN, the population of the Earth will increase by 2 billion people in the next 30 years and reach the mark of 9.7 billion people. In the world 9 countries will account for 50% of population growth over the next 30 years - Pakistan, India, Nigeria, Ethiopia, DR Congo, Tanzania, Indonesia, Egypt and the USA. It is necessary to increase food reserves by 3 times in order to provide such a population with adequate nutrition.

At the beginning of 2022, 190 million people in the world were on the verge of starvation. Today, due to the war in Ukraine, the pandemic and the increase in the cost of energy, their number may increase to 260 million. The violation of food security in the world has the greatest impact on vulnerable segments of the population.

Ukraine is an industrial-agrarian country with a predominance of raw material production. It is one of the leading exporters of some varieties of agricultural products [1]. The food security of the world depends on the export of agricultural products, because Ukraine is a granary for 400 million people.

Agricultural products traditionally occupy the first place in Ukrainian exports. In 2021, Ukrainian farmers exported sunflower oil and grains worth 18.6 billion dollars. World grain prices in 2021 grew rapidly. Some farmers, having a sufficient supply of money, kept their crops in storage. Entrepreneurs expected to sell bread at an even higher price during the sowing season and paid up [2].

The food security of the world is ensured not only by food grains, but also by fodder. If the amount of the fodder is insufficient, the level of providing the population with animal and fish proteins decreases. Meeting the needs of the population in nutrients is a necessary condition for ensuring life.

Poultry products are the most affordable and widespread products for providing the world's population with animal proteins.

Poultry farming is a branch of agricultural production, the main task of which is the breeding, feeding, keeping of poultry, the use of mechanization, automation of technological processes, veterinary prevention in order to obtain eggs, meat and other products (down, feathers, fatty liver, etc.) with low costs of labor and funds [3].

Breeding of poultry is a very profitable business, what is confirmed by the lowest feed costs per unit of production compared to other farm animals. Feed conversion ratio (FCR) in poultry is 2-3:1, in pigs it is 4-6:1. Biological features of poultry, which have a decisive influence on the technology of production of eggs and poultry meat, are determined by their reproductive qualities, rapid growth at an early age, high fertility, intensive metabolism, reaction to stressful situations, specific structure of the gastrointestinal tract and skin [4].

Complete feeds are needed to increase the production of eggs and poultry meat. They fully meet the needs for nutrients and biologically active substances and allow realizing the genetically laid potential of farm poultry. Requirements for the quality of compound feeds are constantly growing and changing as new, more productive animal breeds and poultry crosses appear.

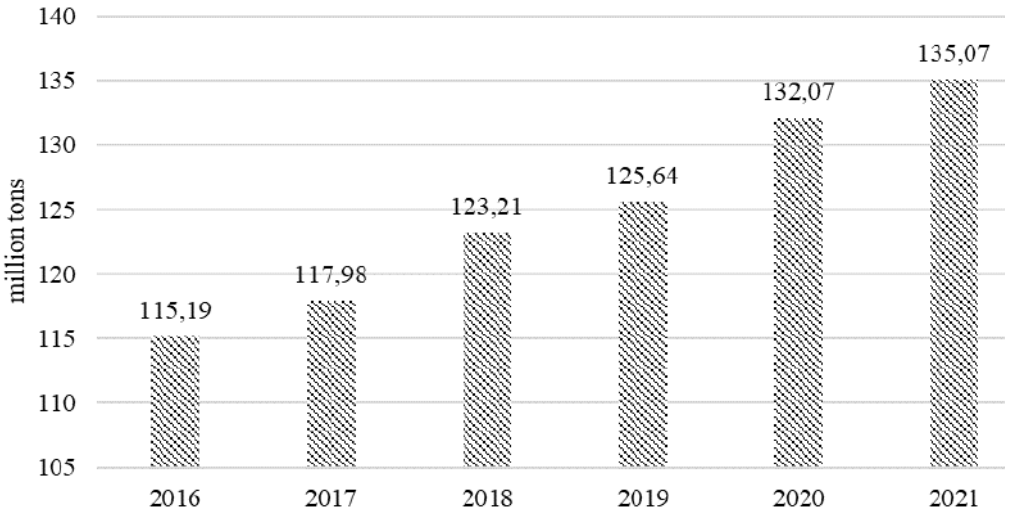

Fig. 1 - Production of poultry meat in the world

The use of compound feeds allows you to regulate the consumption of nutrients and biologically active substances by animals depending on their age, sex, purpose and conditions of keeping. In the composition of compound feeds, animals are fed such fodder, which is difficult to apply separately. For example, fodder animal fats, molasses, table salt, vitamins, salts of trace elements, etc.

The use of compound feeds, especially in granulated form or in the form of grits, excludes selective picking of individual components of the issued portion by animals and poultry [5].

Duck breeding is one of the priority directions for the development of poultry farming in Ukraine. This is an important source of poultry meat, especially in conditions of intensive production.

Purpose and objectives of the analysis

The purpose of the study was to substantiate the feasibility of production of feed for ducks, marketing research and analysis of the feed market for ducks.

Results and its discussion

In January-September 2022, Ukraine exported 301,100 tons of meat and edible poultry offal, which is 9.5% less compared to the same period last year (data from the State Customs Service). In monetary terms, exports for the three quarters of this year amounted to $659.4 million. This is 30.4% more than in the same period of 2021.

The main buyers of domestic meat and edible poultry offal in the nine months of 2022 were the Netherlands (30.7%), Saudi Arabia (27.9%) and Slovakia (6.7%) [6].

When increasing the production of poultry products in conditions of improving the welfare of the population and increasing the number of citizens with a relatively high purchasing power, the expansion of the range of products, the improvement of its quality, up to the point of obtaining the so-called functional food products with specified properties regarding the content of nutrients and biologically active substances, becomes of great importance [7]. The investment attractiveness of the poultry business, the construction of modern large poultry farms and the creation of powerful vertically integrated companies are due to the speed of return on capital investments and the high profitability of the industry.

The volume of poultry meat production in the world is constantly increasing, as can be seen from fig. 1.

In order to determine the position of Ukraine on the world market, we summarized the rating of 45 countries by the level of consumption and production of poultry meat in 2021 (according to the analytical agency Index Mundi) (Fig. 2, Fig. 3).

As can be seen, the traditional leaders in the production and consumption of meat products are the USA, Brazil and China. Ukraine ranks 21st in terms of production (1.175 million tons) and 23rd in consumption (0.89 million tons) of poultry meat.

Analysis of the diagram shows that most countries have a shortage of meat products and can be potential buyers of Ukrainian meat. Ukraine has all the opportunities and prospects for expanding the export of its own products.

The TOP-50 European producers of poultry meat is shown in fig. 4 according to WATT Poultry International (october 2022). As you can see, the third place is occupied by MHP (Ukraine) with an annual volume poultry production of 492 million heads. This is a significant achievement of Ukrainian manufacturers [8].

The Ukrainian chicken market is monopolized by large industrial enterprises (Fig. 5). It is very difficult to compete with such titans. Therefore, there is an opportunity to produce niche types of meat products, namely duck products.

Duck farming is one of the modern dynamic areas of poultry farming and a competitive type of agribusiness, as evidenced by its dynamic development. The perspective and dynamism of this poultry farming area is determined by the high fertility and precociousness of poultry [9].

Duck meat markets are not monopolized by large industrial players, which makes it possible to diversify business and avoid excessive competitive pressure. Export opportunities of niche meat producers to EU countries are significantly inferior in terms of volumes to traditional chicken meat, but this market is distinguished

by its ability to pay.

The profitability of growing one duck exceeds 50%, and depends on the number of livestock.

Raising ducks has certain advantages and disadvantages.

Advantages:

✓ ducks are one of the unpretentious breeds of poultry - the care and feeding procedure is very simple;

✓ in the warm season, the birds themselves find food in the natural environment;

✓ they reproduce well - one individual brings more than 300 eggs every year. If you consider that their fertilization rate and survival of chicks are from 70%,

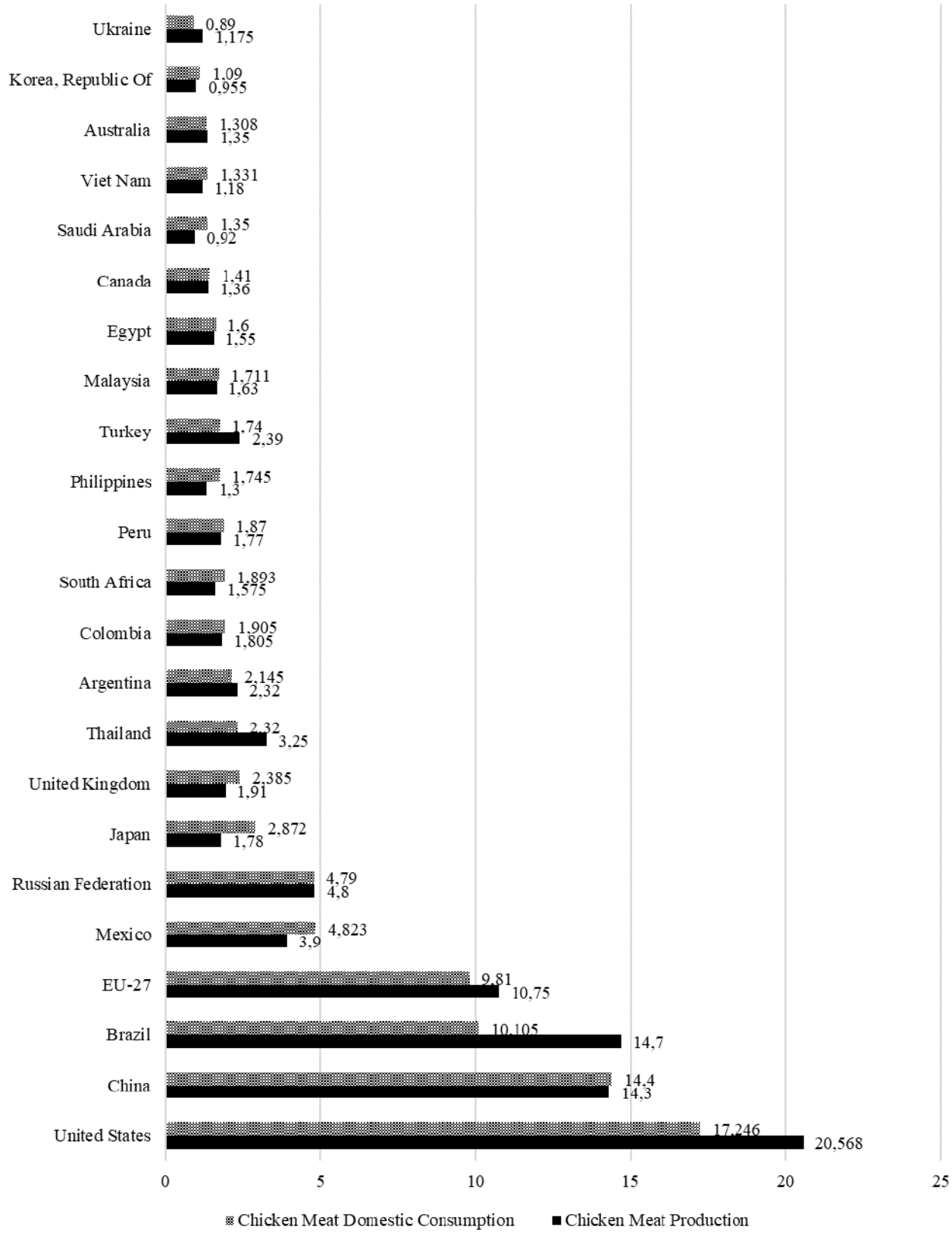

Fig. 2 - Ranking of the world countries by the level of consumption and production of poultry meat in 2021, million tons

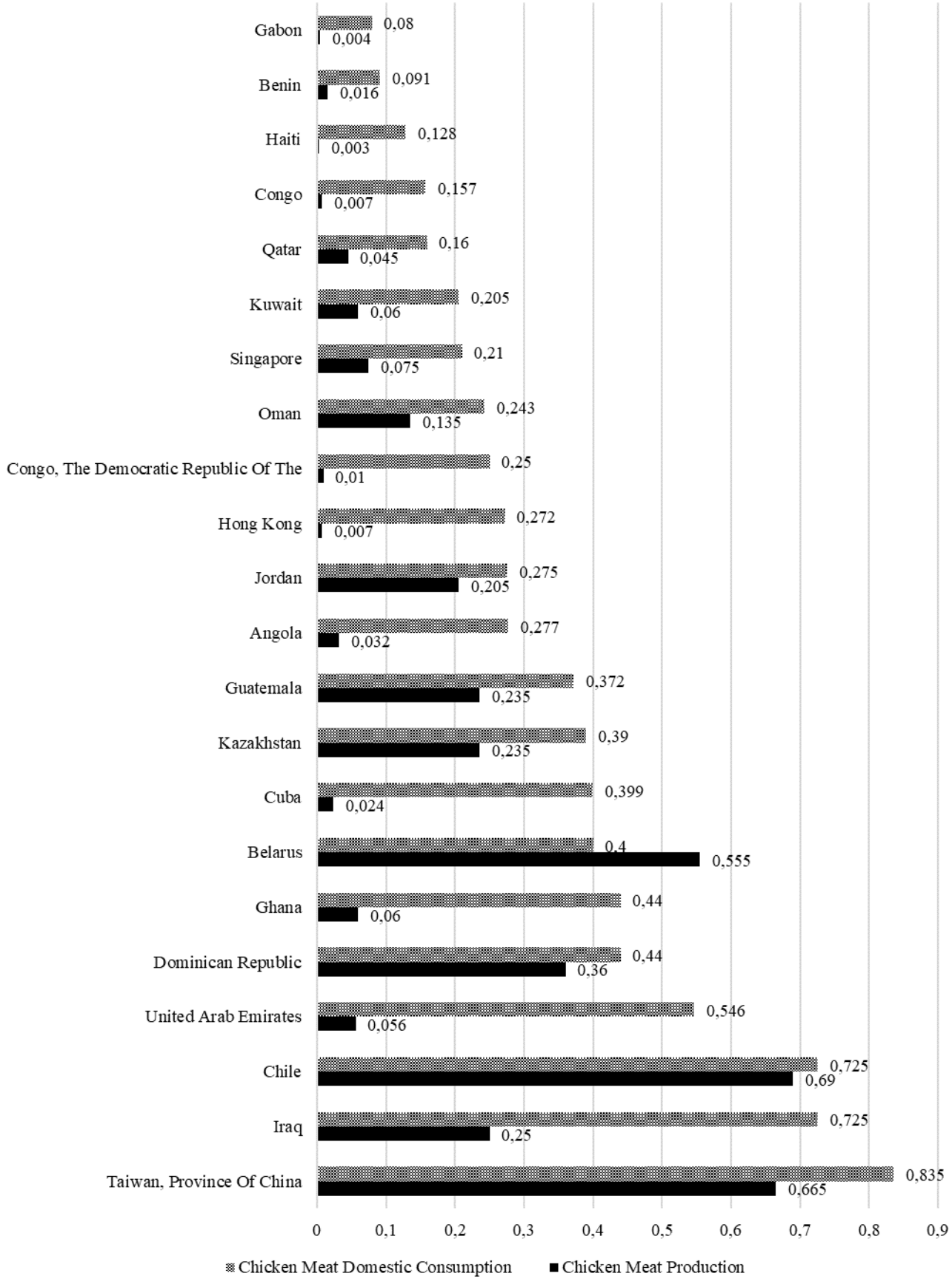

Fig. 3 – Ranking of the world countries by the level of consumption and production of poultry meat in 2021, million tons

WATTPoultry TOP COMPANIES

EUROPE BROILER PRODUCERS

WATT GLOBAL MEDIA

Head slaughtered annually (broilers, millions)	Company	Country	BROILERS	TURKEYS	DUCKS	TABLE EGGS	Full profile
578.5	LDC	France	○	●	○	●	bit.ly/2MJBtjm
520.0	2 Sisters Food Group	United Kingdom	○	●			bit.ly/2w0B0iV
492.0	MHP (Myronivsky Hliboproduct)	Ukraine	○				bit.ly/2TtZ3Dl
468.0	Plukon Food Group	Netherlands	○	●			bit.ly/2MFZurg
27.2	Grupo VMR	Spain	○				bit.ly/3hkGflw
350.0	Gruppo Veronesi	Italy	○	●		●	bit.ly/2SJDizN
350.0	PHW Group	Germany	○	●	○		bit.ly/2vVQFA4
346.8	Resource Agribusiness Group	Russia	○				bit.ly/2MKqxdz
322.4	Cherkizovo Group	Russia	○	●		●	bit.ly/2vVQyEu
312.0	Moy Park Ltd.	United Kingdom	○	●			bit.ly/2vVQaGc
250.0	Amadori	Italy	○	●		●	bit.ly/2MFEi4P
234.0	Avara	United Kingdom	○	●	○		bit.ly/2P81UkU
191.0	Cedrob	Poland	○		○		bit.ly/2w0BxRZ
190.0	Rothkötter-Unternehmensgruppe	Germany	○				bit.ly/2vVQa9a
185.1	Prioskolye	Russia	○	●		●	bit.ly/2nXO9oJ
177.5	Scandi Standard	Sweden	○			●	bit.ly/2MqSAqH
150.6	AgroKomplex	Russia	○		○	●	bit.ly/2Slxt5s
104.0	Akashevskaya	Russia	○			●	bit.ly/2SHUbul
150.0	Sprehe Gruppe	Germany	○	●			bit.ly/2WXYhhv
150.0	Animex	Poland	○	●			bit.ly/2SHUiWN
144.0	Cargill Meats Europe	United Kingdom	○			●	bit.ly/2MFfTMF
130.0	Terrena	France	○	●	○	●	bit.ly/2MrtjNb
115.0	Galliance	France	○	●	○		bit.ly/2MCuvNO
130.0	Eureden	France	○	●	○	●	bit.ly/2MxMwMr
122.4	Koka	Croatia	○	●			bit.ly/3wl1jgi
117.0	Bezrk-Belgrankorm	Russia	○		○		bit.ly/2weW1ps
114.0	Chesterfield Poultry	United Kingdom	○				bit.ly/32NMaHx
110.0	Severnaya	Russia	○				bit.ly/2vZl7Jx

Fig. 4 - TOP-50 European producers of poultry meat (WATT Poultry International, October 2022) [8]

breeding ducks can be called a profitable business;

- ✓ there are several channels of earning profit - eggs, meat, down, feathers, manure as fertilizer;
- ✓ low morbidity of ducks. The mortality of the birds flock is a rare phenomenon;
- ✓ the demand for duck meat and eggs is not tied to the season.

Disadvantages:

- ✓ ducks are voracious;
- ✓ they need a large area for walking;
- ✓ the presence of a reservoir is mandatory;
- ✓ with improper nutrition or maintenance, the palatability of meat deteriorates, the demand for the product decreases [10].

Ukraine is one of the largest producers of duck meat in Europe. On a global scale, the duck market is 5% of the chicken market. The low level of duck meat production in the world (except Asia) is explained by the seasonality of consumption. Duck meat is in the greatest demand for New Year's holidays. The priority task of the

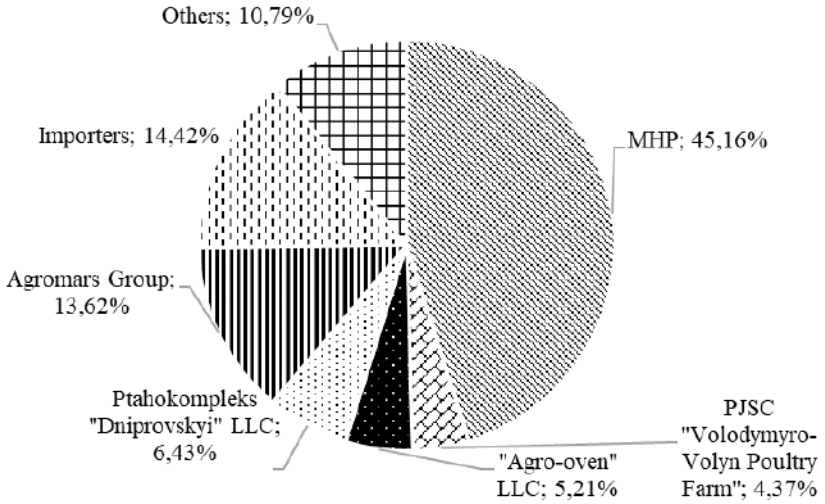

Fig. 5 – The main industrial producers of poultry products in Ukraine

development of duck farming in Ukraine is the protection of the domestic market and the development of the export of products to world markets.

Today, approximately 0.7 kg of duck meat is consumed per inhabitant in Ukraine. This level means that one average family can taste duck once a year. At the same time, the decrease in duck meat production in Ukraine has been going on for at least 25 years. Only compared to 2000, its production decreased by 2.1 times.

The selling price of duck meat is 20-30% higher than that of broiler meat. Given the low purchasing power of the majority of the population, this factor also had a significant impact on the decrease in duck meat consumption in Ukraine. About 90% of duck meat is produced on homestead farms. Existing duck enterprises are mainly focused on meeting the needs of the population in daily young birds. At the same time, this meat is consumed the most in Hungary (3.6 kg per person) and France (3.4 kg per person). These countries rank second and third, respectively, in terms of consumption of duck meat in the world after Malaysia, which leads the list. Southeast Asian countries dominate the production and consumption of dark duck meat, 80% of the world volume. In China, duck meat is preferred as a healthy food product. In Chinese supermarkets, ducks are cheaper than broilers, although their cost is on average 20% higher. This situation is unique for the world market. In Asia, North America and some regions of Europe, it has already become a tradition to include exquisite duck dishes in the menu of expensive restaurants [11, 12, 13].

The global market for duck meat will experience moderate growth in the next 7 years due to the increase in demand for this type of poultry meat in Asian countries. Analysts expect an increase in the market volume to 8 million tons by the end of 2025, as the projected growth will be +1.6% per year [14]. According to 2021 data, the main exporters of duck meat in the world were Hungary, China, and Poland, and the main importers were Germany, Hong Kong, and France.

Industrial production of duck meat in Ukraine should focus on export to Asian and European countries, where this product is in greater demand than at home.

In fig. 6 the dynamics of changes in the duck population by category of farms (according to the State Statistics Service of Ukraine) is presented. In the first years of Ukraine's independence, there was a decline in agricultural production, duck breeding is no exception. Their population decreased by analogy with other farm animals. But already at the beginning of 2000, the rapid development of poultry farming began, which is explained by the presence of stable foreign markets for the sale of poultry meat and high profitability. Starting from 2020, the number of ducks in all Ukrainian enterprises began to decrease due to the coronavirus pandemic, logistical complications, and from 2022 - due to a full-scale war in Ukraine. In our country, duck breeding is mainly done by households, and industrial production is not sufficiently developed. The limited demand for fatty and high-calorie duck meat and the absence of poultry slaughtering enterprises discourages potential poultry entrepreneurs.

It is possible to single out several main stages of the transition of the industry to an industrial production method in the history of the domestic duck farming development. It is associated with the development and practical assimilation of following technological methods:

✓ breeding and maintenance of ducks without ponds;

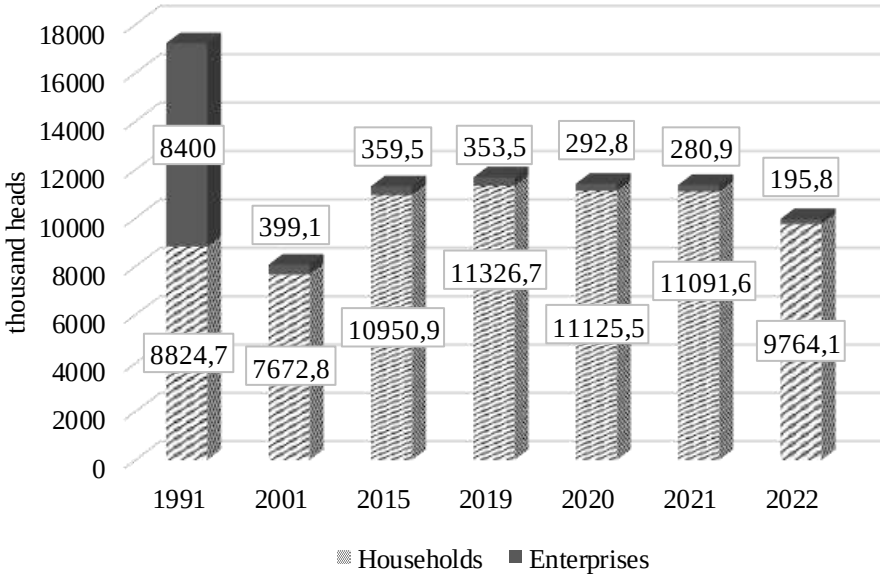

Fig. 6 – Dynamics of changes in the duck population by category of farms (according to the State Statistics Service of Ukraine)

✓ multiple stocking of the parent flock of ducks;

✓ feeding ducks with dry complete feeds;

✓ rearing ducklings on a mesh floor and in cage batteries.

Industrial means of production made it possible to turn duck farming into one of the most effective branches of poultry farming. At the same time, it is possible to successfully combine year-round production with seasonal production in duck farming [3].

With proper organization the business of raising ducks is economically feasible and practically waste-free. The main products of production are meat, eggs, down and feathers, droppings and duck liver.

The main product of industrial duck farming is meat. It has high taste and dietary properties. There is a false claim that duck meat is a source of cholesterol due to its high fat content. However, it has a high level of digestibility and its use contributes to better functioning of the gastrointestinal tract. Duck meat, in addition to fatty acids, contains a large number of various vitamins and minerals: vitamins A, E, K, all B vitamins. Although it is difficult to get their daily allowance only from duck meat, together with other products, the composition of the duck is quite capable of providing the body with many substances necessary for life. As numerous scientific studies show, regular consumption of duck meat contributes to the prevention of atherosclerosis, varicose veins, heart diseases, also strengthens vision, improves memory and reaction, improves the condition of nails and hair, and increases hemoglobin. In the modern condi

tions of the war in Ukraine, the use of duck meat is becoming more relevant for suppressing stress and depression.

Duck eggs were not widely distributed among the population due to their specific taste and smell, as well as the possibility of contamination with salmonella and other pathogenic bacteria through the surface of the egg. They are mainly used in bakeries, cosmetology and stored for incubation.

Duck down and feathers make up less than 5% of the economic value of the bird. They are used for the manufacture of pillows, blankets, clothes and are characterized by high thermal insulation properties and a long period of effective operation. However, duck feathers are valued less than goose feathers because of their stiffness, elasticity and the ability to clump.

Duck droppings can be used as a valuable organic fertilizer, which is not inferior to mineral fertilizers in terms of effectiveness. In addition, the technology of biogas production from bird droppings has recently become widespread.

Duck liver is a delicate product with a unique chemical composition and valuable biological and medicinal properties. The world production leaders are France, Hungary, and Belgium. The weight of the liver is on average 300-400 g.

According to world practice, duck breeding can be a profitable business in two options. The first is the creation of a small (mainly seasonal) farm with minimal investment in capital facilities, where the poultry can feed on pasture. The second is the construction of a modern complex for several hundred thousand or millions of heads, where cost reduction is achieved due to large volumes and waste-free production, when everything, including droppings and feathers, becomes a commodity [13].

Conclusions

Based on marketing research, it has been proven that a third of consumers in the world prefer poultry meat. The investment attractiveness of the poultry business in Ukraine due to the quick payback of capital investments and the high profitability of the industry is justified.

The dynamics of poultry meat production in the world and a generalized rating of 45 countries by the level of consumption and production of poultry meat in 2021 were analyzed. It has been proven that most countries have a shortage of meat products and can be potential buyers of Ukrainian meat.

The expediency of meat products diversification due to the production of duck products, which are in demand in Asian countries and can be exported, is justified. The business of raising ducks is almost waste-free with the production of eggs, meat, down, feathers, droppings and duck liver.

REFERENCES

1. Kachki // Vikipediya [Veb-sayt]. - Odesa, 2022. - URL: https://uk.wikipedia.org/wiki/%D0%A3%D0%BA%D1%80%D0%B0%D1%97%D0%BD%D0%B0#:~:text=%D0%A3%D0%BA%D1%80%D0%B0%D1%97%D0%BD%D0%B0%20%E2%80%94%20%D0%BF%D1%80%D0%BE%D0%BC%D0%B8%D1%81%D0%BB%D0%BE%D0%B2%D0%BE%2D%D0%B0%D0%B3%D1%80%D0%B0%D1%80%D0%BD%D0%B0%20%D0%BA%D1%80%D0%B0%D1%97%D0%BD%D0%B0%20%D0%B7,%D1%87%D0%BE%D1%80%D0%BD%D1%83%20%D0%B9%20%D0%BA%D0%BE%D0%BB%D1%8C%D0%BE%D1%80%D0%BE%D0%B2%D1%83%20%D0%BC%D0%B5%D1%82%D0%B0%D0%BB%D1%83%D1%80%D0%B3%D1%96%D1%8E%20%D1%82%D0%BE%D1%89%D0%BE (data zvernennya: 12.10.2022).
2. A shcho v nas z eksportom ta importom? Yak Ukrayina torhuye v umovakh viyni? Ekonomichna pravda [Veb-sayt]. - Odesa, 2022. - URL: https://www.epravda.com.ua/publications/2022/03/25/684674/ (data zvernennya: 14.08.2022).
3. Patryeva L.S. Tekhnolohiya virobnitstva produktsiyi ptakhivnitstva: kurs lektsiy / L.S. Patryeva, O.A. Koval` - Mikolayiv: MNAU, 2018. - 248 s.
4. Svezhentsov A. I. Korma i kormlenie sel`skokhozyaystvennoy ptitsy: monohrafiya / A. I. Svezhentsov, R. M. Urdzik, I. A. Ehorov - Dneprovpetrovsk: ART-PRESS, 2006. - 384 s.
5. Makarynska A., Vorona N. PECULIARITIES OF GROWING AND ANALYSIS OF FEEDING PROGRAMS TURKEYS // Grain Products and Mixed Fodder's. 2019., No. 3 Vol. 19. P. 27-33.
6. Na eksporti m'yasa ptitsi za 9 misyatsiv Ukrayina zarobila na 30,4% bil`she // Ukrahrokonsalt [Veb-sayt]. - Odesa, 2022. - URL: https://ukragroconsult.com/news/na-eksporti-myasa-ptyczi-za-9-misyacziv-ukrayina-zarobyla-na-304-bilshe/ (data zvernennya: 09.09.2022).

7. Vorona N. V. Analiz suchasnikh mozhlivostey ta perspektiv u husivnitstvi / N. V. Vorona; ONAKhT. - Odesa: ONAKhT, 2020. - 35 s.
8. Clements M. Top world broiler and egg rankings 2022 // WATTPoultry International. 2022., No. 10 Vol. 61. P. 6-51.
9. Kas'yanenko S. M. Sums`kiy natsional`niy ahrarniy universitet / S. M. Kas'yanenko // Rozrobka al`ternativnikh metodiv profilaktiki bakterioziv kachok. - ODesa, 2022. - URL: https://science.snau.edu.ua/wp-content/uploads/2021/07/Annotation_Kasianenko.pdf. (data zvernennya: 16.10.2022).
10. Pribitok P. Rozvedennya kachok – yak realizuvati biznes-ideyu z nulya? / P. Pribitok // Biznes i Finansi v Ukrayini. - Odesa, 2022. - URL: https://dumka.biz/rozvedennya-kachok-yak-realizuvati-biznes-ideyu-z-nulya/ | Biznes i Finansi v Ukrayini (data zvernennya: 13.07.2022).
11. Ukrayina ye odnim iz naybil`shikh virobnikiv kachinoho m'yasa v Yevropi // Kurkul. - Odesa, 2022. - URL: https://kurkul.com/news/8143-ukrayina-ye-odnim-iz-naybilshih-virobnikiv-kachinogo-myasa-v-yevropi (data zvernennya: 03.06.2022).
12. Ukrayinets` spozhivaye bliz`ko 0,6 kh kachinoho m'yasa na rik // Ahrotayms. - Odesa, 2022. - URL: https://agrotimes.ua/tvarinnitstvo/ukrayinec-spozhivae-blizko-0-6-kg-kachinogo-m-yasa-na-rik/ (data zvernennya: 13.06.2022).
13. Vodoplavne zrostannya // Ahrotayms. - Odesa, 2022. - URL: https://agrotimes.ua/article/vodoplavne-zrostannya/ (data zvernennya: 25.05.2022).
14. Svitove spozhivannya m'yasa kachok ta husey zroste do 8 mln tonn // Meat-inform. - Odesa, 2022. - URL: https://meat-inform.com/novyny-pro-miaso/svitove-spozhyvannia-m-iasa-kachok-ta-husei-zroste-do-8-mln-tonn.html (data zvernennya: 10.09.2022).

УДК 637.54:658.628:005.52

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АНАЛІЗ РИНКУ М'ЯСА ПТИЦІ ТА ОБГРУНТУВАННЯ РОЗШИРЕННЯ ЙОГО АСОРТИМЕНТУ

Анотація

На основі маркетингових досліджень доведено, що третина споживачів у світі віддають перевагу м'ясу птиці. Встановлено, що інвестиційна привабливість птахівничого бізнесу, будівництво сучасних великих птахофабрик і створення потужних вертикально інтегрованих компаній зумовлені швидкістю повернення капітальних вкладень і високою прибутковістю галузі. Для визначення позиції України на світовому ринку було узагальнено рейтинг 45 країн за рівнем споживання та виробництва м'яса птиці у 2021 році. Традиційними лідерами у виробництві та споживанні м'ясної продукції є США, Бразилія та Китай. Україна займає 21 місце за виробництвом і 23 місце за споживанням м'яса птиці. Більшість країн мають дефіцит м'ясної продукції і можуть бути потенційними покупцями українського м'яса. Україна має всі можливості та перспективи для розширення експорту власної продукції. Обґрунтовано, що качківництво є одним із сучасних динамічних напрямків птахівництва та конкурентоспроможним видом агробізнесу, про що свідчить його динамічний розвиток. Перспективність і динамічність цього напряму птахівництва визначається високою плодючістю та скоростиглістю птиці. Ринки качиного м'яса не монополізовані великими промисловими гравцями, що дозволяє диверсифікувати бізнес і уникнути надмірного конкурентного тиску. Експортні можливості нішевих виробників м'яса до країн ЄС значно поступаються за обсягами традиційній курятині, але цей ринок вирізняється платоспроможністю. Україна є одним з найбільших виробників качиного м'яса в Європі. У світовому масштабі ринок качки становить 5% ринку курятини. Низький рівень виробництва качиного м'яса в світі (крім Азії) пояснюється сезонністю споживання. Пріоритетним завданням розвитку качківництва в Україні є захист внутрішнього ринку та розвиток експорту продукції на світові ринки. Промислове виробництво качиного м'яса в Україні слід орієнтувати на експорт до країн Азії та Європи, де цей продукт користується більшим попитом, ніж на батьківщині. Встановлено, що при належній організації бізнес з вирощування качок є економічно доцільним і практично безвідходним. Основною продукцією виробництва є м'ясо, яйця, пух і пір'я, послід і качина печінка.

Ключові слова: качки, повнораціонні комбікорми, м'ясо птиці, промислові виробники, світове споживання та виробництво, нишеві типи м'ясної продукції.

Received 24.08.2022 **Revised 28.09.2022**
Reviewed 16.09.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Makarynska A., Vorona N. Analysis of the poultry meat market and justification of expanding its range. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 25-32. **DOI** https://doi.org/10.15673/gpmf.v22i3.2459

Cite as State Standard of Ukraine 8302:2015
Analysis of the poultry meat market and justification of expanding its range. / Makarynska A. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 25-32. **DOI** https://doi.org/10.15673/gpmf.v22i3.2459

UDC 664.7 : 502
DOI https://doi.org/10.15673

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GRAIN PROCESSING PRODUCTS IN RATIONAL HUMAN NUTRITION

Annotation

Due to the fact that products of plant origin are widely used by all contingents of the population and are mandatory in rational nutrition due to the significant content of vitamins, minerals, complex carbohydrates, specific substances, the topic of their use in rational nutrition needs even more careful study. It also requires attention due to the fact that it is important for doctors to know the peculiarities of the composition and properties of bread, bakery products, cereal products, legumes and other products of grain processing, their general and specific effects on the body, an appropriate combination of the possibility of giving them certain properties with the help of dietary cooking techniques for their effective use in rational, curative, curative and preventive nutrition. The article reveals the concepts, content and requirements for rational human nutrition, taking into account the specific needs of different groups of consumers. The urgency of harmonizing the nutrition structure in terms of energy and quality components with changes in the ecological state of the environment and the sharpening of the moral and ethical sensitivity of society to livestock sources of nutrition is noted. The attention is focused on the growing problem of the ecological component of the industrial industry of the products of animal husbandry complexes and the search for a compromise in the increased production of products of plant origin, an expanded range of grain processing products, the selective use of their anatomical components and the application of technologies of different depth of their processing. In addition to the ecological component of the advantages of plant products over animal products, the economic and qualitative expediency of this is also given. In particular, it was noted that the selective use of various anatomical components of grains can change the energy value of food products by 1.5-2.0 times, several times – the content of vitamins, microelements and biologically active components, such as enzymes or enzymes. In addition, using advanced processing technologies, it is possible to significantly control the nutritional value of grain products, namely, a several-fold increase in the content of dextrins or pasteurized starch grains. The possibility of combined use of various grain crops in combination with the specified technologies of their in-depth processing makes it possible to provide products with preventive and curative properties. A positive trend of intensification of the domestic grain industry and growth of its scientific potential was noted. That is why such vegetable sources of human nutrition as grain products, in combination with various technologies of their processing, should be used to cover the shortage of sources of products of animal origin, to reduce the negative impact of animal husbandry activities on the ecosystem of the planet, and to use them differently in the nutrition of consumers, taking into account the peculiarities of activity their vital activities or age status, as well as to improve the availability of food products for socially vulnerable sections of the population.

Keywords: grain, cereals, nutritional value, quality, energy, ecology, nutrition, technologies.

Formulation of the problem

The potential of the domestic agrarian industry allows to grow grains four times more than the state's internal need for them. In addition, the two-fold reserve of production capacities of grain processing enterprises in combination with the scientific potential of domestic food universities can satisfy the current and prospective needs of the population of a number of countries in socially significant food products, increase the gross domestic product and profitability of enterprises. It is possible to increase the potential of using the production capacities of domestic enterprises by expanding the assortment of food products and their components. Such a direction can be scientifically balanced use of various grain and anatomical constituents of grains with given technologies of their processing to improve the social significance or availability of targeted food products, taking into account the characteristics of different age groups and the activity of the consumer's life, as well as providing such products with therapeutic and preventive properties. In the technological schemes of the majority of domestic flour mills, grain mills and compound fodder enterprises, wet-heat and specified types of deformation methods of processing are provided.

The purpose of the work: the socio-ecological expediency of increasing the share of grain products of various processing technologies in the human diet.

Materials and methods

Analytical and applied using traditional scientific methods of research, the results of well-known and proprietary methods and experimental data on changes in the chemical composition of grains, in particular, an increase in the content of dextrins and starch grains that are not pasteurized by wet-heat processing technologies, IR irradiation, extrusion, flattening, and others.

Introduction

Today's socio-ecological challenges force us to reconsider the food culture, leveling the ideological dif-

ferences of the sacred "Eat - to live" or "Live - to eat". Why, even G. Heinove's "A man is what he eats" is leveled due to the dominance of the narrative of functional nutrition and social and ecological challenges. Issues of rational human nutrition acquire a new meaning in the context of the use of functional food products, which appear as a compromise of different views on the subject and function of food. At the same time, at present, rational nutrition embodies functional nutrition to a certain extent and levels the differences, minimizes the difference between different groups of consumers of these products. The deepening of knowledge about grain and the improvement of grain products technologies allow making changes to the traditional scale of full-fledged and even prestigious nutrition. And the ecological challenges and demographic risks of our planet make us reconsider the concept of food sources and expand the range of food, if not for all of humanity, then at least for a larger part of it. In this context, grain products do not act as a supplement or even as an alternative to products of animal origin, but the only possible solution to eliminate the shortage of food products, moreover, in combination with the leveling of environmental risks of animal husbandry.

Content of research

The energy value of various fruits of vegetable origin, depending on their chemical composition, varies in a wide range from 16 MJ/kg of grain and leguminous crops to 29 MJ/kg of oil crops [1, 3, 6, 8, 13, 14]. In addition, the significant difference in the chemical composition of various anatomical components of grains also determines their differences in energy and nutritional value. Such a variety of the chemical composition of plant fruits and their anatomical components makes it possible to selectively use these differences to meet the individual needs of various food consumers. In particular, repeatedly control the content of vitamins, microelements and biologically active components such as enzymes or enzymes.

In addition, advanced processing technologies can also significantly control the nutritional value of grain products [3, 5, 6, 7, 14], including multiple changes in the content of dextrins or pasteurized starch grains [12-14]. Grain products using different technologies of their processing can cover the shortage of products of animal origin, weaken the negative impact of animal husbandry activities on the ecosystem of the planet, improve the availability of food products to socially vulnerable segments of the population, and also provide these products with preventive and curative properties [1, 3, 4 –14].

For a balanced establishment of the rational composition of a person's food, one should take into account not only the chemical composition of his body (Table 1), but also the peculiarities of the body's needs for its full functioning, as well as the mechanism of absorption of food components by the digestive organs [1, 3, 4-14]. Taking this into account, a balanced diet based on groups of chemical compounds such as proteins, carbohydrates, fats, and minerals is generally accepted as presented in Table 1 [3, 8, 14]. From the same table 1, we can note a certain similarity in the chemical composition of rational food and wheat grain, except for the fat content.

Table 1 – Chemical composition of the human body, diet and wheat grain, % [1 – 3, 8, 14]

№	Chemical element	Human body	Rational nutrition	Grain
1	Water	60		14,0
2	Protein	20	13	12,0 – 16,0
3	Carbohydrates	1	60	55,0 – 65,0
4	Fats	14	26	1,5 – 2,4
5	Mineral speeches	5	1	2,1 – 2,5
	Total	100	100	100

In fact, it is precisely for the full-fledged formation and maintenance of vital activity that the body needs a variety of chemical compounds, in different quantities and forms, both for independent use and in various compounds and ways of use. They include 7 most influential groups [1, 3, 4 – 13]. These are proteins, fats, carbohydrates, nucleic acids, ballast substances, vitamins and mineral substances of multifunctional purpose for the formation and vital activity of the body. It is obvious that even with the similarity of the chemical composition of grain products with rational human nutrition, the body's needs can only be met by combining different products. Taking into account the above analysis of the potential opportunities of grain products to satisfy human needs for food, we suggest below to perform simple calculations on the state of food supply for the population of our planet.

Based on the energy needs of the human body and its active functioning, below are calculations of the annual need for food products of the population of our planet in terms of grain products. For example, if the average daily energy requirement from food per person is approximately 12 MJ with moderate physical exertion, then based on the current population of our planet (in 2022) (7,950 million people) it will be 34.8 ·1012 MJ/year. Taking into account the chemical composition of cereals and their energy capacity, taking into account the technological output of the finished products of a grain processing enterprise, the annual human need for food products in grain equivalent amounts to approximately 2,570 million tons. Taking into account the reported data of the FAO (UN) on world cultivation in the current (2021/2022 year) of grains in the amount of 2,799 million tons, with a market demand for them of 2,785 million tons, a seemingly optimistic assessment is made with the food supply of mankind in food products, even without taking into account energy from other sources of food, such as animal origin, as well as vegetables, fruits, seafood, etc.

On the other hand, according to the same information sources, 861 million people, or every ninth inhabitant of the planet, suffer from a shortage of food energy in the world this year. Under the conditions when the projected world population reaches 9.7 billion people in 2050, the share of people who will suffer from food shortages will definitely increase rapidly by at least (9.70 – 7.95 + 0.86 = 2, 61) for 2.6 billion people, or up to 27% of the population of our planet. The given calculations testify to the irrational use of plant products, in particular

for the supposed needs of the functioning of livestock farms. However, is it really so? And can domestic grain processing enterprises take advantage of the complex situation of food energy deficit and its imbalance in terms of nutrients by increasing the unused potential of their production capacities?

First of all, again, we offer a little light economy on the feasibility of using products of animal origin. According to German scientists, the analysis of the necessary areas for the operation of livestock farms and the ratio of rotation of feed into livestock products proves the disappointing conclusion that the potential of the livestock industry of food products is currently at the limit of its extensive capabilities. In addition, with the development of social relations of an industrial society, today we cannot ignore the position of vegetarians regarding the inhumane use of animal food, aggravated by the economic impracticality of 30-40 times overspending of the equivalent of its production from plant products, as well as critical pollution of up to 40% of the environment by the results of animal life namely the food industry [4, 8 – 10].

All this together determines the urgent need to revise the concept of the world food industry, to change the structure of the sources of meeting the needs of mankind in food products.

Along with the energy component of the human diet, its qualitative composition is even more relevant. Below, in the table. 2 and 3 [3, 8 – 10, 14] outline the main consequences of the deterioration of the human body, associated with violations of the nutritional (quality) balance of food.

By themselves, the tabular data below are quite telling and probably do not need lengthy explanations. Instead, we will note only two, in our opinion, the most important factors. First of all, public health problems are directly related to nutrition and are inherent not only in economically underdeveloped countries, with their food shortages, but also in industrialized, economically successful countries, with their overburdening and nutritionally unbalanced diets (tables 2, 3) [3, 8 – 10, 14].

From column 4 of table 3 we can note that, if not all, then most of the diseases associated with a violation of the nutritional balance of human nutrition can be prevented by the selective use of a mixture of various cereal fruits and their anatomical components.

For the given management of the nutritional value of food products for the prevention of certain diseases below in the table 4 and 5 show the averaged indicators of the chemical composition of the most common pea, leguminous and oilseed crops and their anatomical components of wheat grain, respectively.

As we can see from the table 4 data, the highest energy value corresponds to sunflower seeds:

$$Q=36\cdot54.5/100+21\cdot18.5/100+19\cdot20.2/100=27.3 \text{ MJ/kg}, \quad (1)$$

And the smallest is a buckwheat grain:

$$Q=36\cdot3.1/100+21\cdot13.1/100+19\cdot67.8/100=16.8 \text{ MJ/kg}, \quad (2)$$

Thus, by combining the composition of various fruits of grain, leguminous or oil crops, we can manage the *energy value* of a person's diet according to his social activity, age group or other characteristics.

Table 2 – Consequences of a violation of the energy balance of nutrition [3, 8 – 10, 14]

Eating disorder	Consequences	Geography
Malnutrition	Exhaustion of the body, weakening of immunity, slowed growth of children, impaired well-being and activity, higher risk of diseases, with fatal consequences of up to 50% due to malnutrition	Central and North Africa, the Middle East, South Asia, the countries of the Caribbean
Overeating	Excess weight, cardiovascular disease, high blood pressure and the risk of heart attack, diabetes, tooth decay, disorders of the alimentary tract, liver disease and various forms of cancer, more than half of the premature deaths of people under the age of 65 are related to nutrition of diseases	Industrially developed countries, countries of Central and some Eastern Europe

Table 3 – Consequences of a violation of the nutritional balance of food [3, 8 – 10, 14]

№	Morbidity and its consequences	Reasons	Methods of elimination
1	fatigue, headaches	B2 (pantothenic acid)	embryo, yolk, legumes, fish
2	nyctalopia	A (retinol)	corn, fish oil, vegetables, fruits
3	anemia	B2 (folic acid)	wheat germ, liver
4	muscle atrophy	E (tocopherol)	wheat germ, oat flakes, bran
5	rickets	D - ultraviolet,	Fish Oil
6	blood clotting	K (phylloquinone)	
7	beriberi (weakness, loss of appetite, increased excitability, heart attack)	B1 (thiamine)	bran products, liver, legumes
8	weakening of immune protection	complex of vitamins	various food products
9	protection against cancer	Reasons	

Table 4 – Chemical composition of grain and seeds (in % of completely dry matter, [1, 2, 7])

Culture	Proteins	Fats	Carbohydrates	Fiber	Ash
Wheat is soft	13,9	2,0	79,9	2,3	1,9
Wheat is hard	16,0	2,1	77,4	2,4	2,0
Rye	12,8	2,0	80,9	2,2	2,1
Barley	12,2	2,4	77,2	5,2	2,9
Corn	11,6	5,3	78,9	2,6	1,5
Oat	11,7	6,0	68,5	11.5	3,4
Fig	7,6	2,2	72,5	11,8	5,9
Millet	12,1	4,5	69,8	9,2	4,3
Buckwheat	13,1	3,1	67,8	13,1	2,8
Pea	24,0	2,7	62,9	5,5	2,8
Bean	26,9	2,4	62,8	4,2	3,8
Soy	40,1	22,5	23,5	9,1	4,8
Lentil	28,1	2,0	61,8	4,6	3,2
Sunflower	18,5	54,5	20,2	3,2	3,4

On the other hand, taking into account the difference in the chemical composition of various anatomical components of grain (Table 5), their selective use in the calculations of the composition of rational nutrition, it is possible to control the *therapeutic and preventive properties* of a given diet. Taking into account the specific needs of not only age groups or physical activity, but also the state of health.

The preventive and curative function of food to eliminate food-related diseases is quite diverse. In this aspect, it is the products of grain processing that play almost the most significant role in human nutrition, which is based on their affordability, the largest share of use in the diet, the wide range of energy value of grain products of different chemical composition and the various content of therapeutic and preventive substances contained in different anatomical constituents of cereals of different groups of cereals.

In the presence of modern computer technologies and thorough studies of the chemical composition of grains of various groups and their anatomical components, today it is no longer difficult to calculate the rational diet of the consumer according to his individual characteristics in the need for nutritional, therapeutic and preventive substances.

For example, let's take wheat grain, one of the most widely consumed grain crops in the world. From the chemical composition of various anatomical components of wheat grain shown in Table 5 and their therapeutic and preventive properties shown in Tables 3, 6 and 7, by combining the components of these anatomical components and varying their content, we can change not only the chemical composition and nutritional value of the obtained mixture, as well as curative and preventive properties.

The data of Tables 6 and 7, as well as the previous ones, prove the expediency of wider use in prophylactic and curative nutrition of specified mixtures of various pea, leguminous and oil crops, individual anatomical components of their grains, both in native and technologically processed forms , with the addition of fruits and other vegetable products.

So, as we were able to see from the above data, the potential of grain products in human nutrition is not limited only to their energy value. Their selective use can prevent, and even treat, a number of diseases characteristic of the human body. In particular, such as overweight, indigestion, atherosclerosis, anemia, gallstone disease, loss of appetite, increased excitability, cardiovascular disorders, muscle atrophy, fatigue, headaches.

Table 5 – Distribution of chemical substances in anatomical components of wheat grain [1, 7, 11, 14]

Chemical elements	Fruit membranes, %		Seed membranes, %		Aleurone layer, %		Endosperm, %		Embryo, %	
	to the grain	to the shells	to the grain	to the shells	to the grain	to the aleurone layer	to the grain	to the endosperm	to the grain	to the endosperm
Moisture	0,5	11,2	0,13	11,8	1,03	11,8	11,26	13,20	0,16	11,2
Cellulose	3,5	78,6	0,73	66,3	4,29	48,8	0,24	0,28	0,45	31,41
Protein	0,35	7,8	0,18	16,3	2,2	25,0	8,6	10,10	0,56	39,2
Ash	0,09	2,4	0,06	5,6	0,48	5,3	0,40	0,47	0,08	5,6
Fat	--	--	--	--	0,8	9,7	0,79	0,94	0,18	12,6
Starch	--	--	--	--	--	--	62,91	75,01	--	--
In total	4,45	100	1,10	100	8,8	100	84,2	100	1,43	100

Table 6 – Chemical composition of fruits and cereals [2, 3, 6, 7, 8, 10, 12]

Names	Proteins (N), %	Fats (S), %	Carbohydrates (C), %	Minerals, %	Ballast substances, %	Moisture, %
Fruits (generalized)	1	0,3	8	1	3,7	86
Crops	8 – 15	2,2 – 6,0	65 – 80	2,2 – 3,2	8 – 18	12 – 15

Table 7 – Vitamin content in fruits and cereals [2, 3, 6, 7, 8, 10, 12]

Products	*A*	*C*	B_1	B_2				B_6	B_{12}	*Д*	*E*	*K*
				riboflavin	nicotinamide	folic acid	pantothenic acid					
	Chicken blindness, skin peeling	Scurvy, immunity	Beri-beri	The growth of the child's, body depressed mood	Pellagra	Anemia	Fatigue, headaches	Convulsions, excitement, skin	Severe anemia	Rickets	Reproduction	Skin folds
Fruits, vegetables	high	high	traces	traces	traces	traces	traces	traces	traces	traces	traces	high
Cereals, legumes, oilseeds	high	traces	high	high	high	high	high	high	traces	traces	high	traces

All this is a far from complete list of diseases that can be prevented and treated by selective anatomical components of grains of different groups of grains, their given combination and the use of advanced technologies for managing the nutritional properties and biochemical activity of grain products.

And the data given in the table. 8 also prove the possibility of prevention, and even treatment of many common diseases associated with nutritional disorders, easily available and relatively inexpensive components of grain.

It seems that supermarkets will have to install a few additional consumer shelves with functional food products for targeted preventive and therapeutic use. In particular, those with increased or decreased energy value, suffering from beriberi, overweight, cardiovascular or high blood pressure, headaches, etc. (see Table 3).

A completely justified question arises: are domestic flour mills, grain mills and compound fodder enterprises able to join the issues of production of curative and preventive grain products? Are there enough scientific developments of domestic scientists on these issues? And the answer is only yes! The technological schemes of grade grinding of 159 domestic mills provide for the use of wet-heat treatment methods [12]. And actually, the technological scheme itself provides for the separation from the grain of its anatomical components indicated in Table 3. In addition, the use of various technological equipment of the grinding department of the mill [12] allows applying different types of deformation of the anatomical components of the grain, such as compression, shear, abrasion or their combination. The specified complex technological methods of processing grain and anatomical components of grains of a mill plant of graded mills in combination with the regimes recommended by scientists of ONAFT and NUFT [6, 12, 14] allow us to confidently assert the possibility of producing grain products with preventive and curative properties at domestic flour milling enterprises. If the actual utilization of the total production capacity of domestic graded flour mills from the production of 7,327 thousand tons of graded flour per year is less than 50%, increasing their workload will not only be possible, but also expedient. The situation is similar with the technological potential of domestic grain mills and feed mills.

In conclusion, we would like to cite the recommendations of the German Nutrition Society for a rational diet. This society substantiated and proved to the general public 10 rules of a *complete diet*. We will list some of them.

First of all, food must be balanced in terms of nutrients and energy capacity. Under these circumstances, it should be borne in mind that the dominant group of food products in terms of energy, ballast substances, proteins and B vitamins are *cereal products* and *potatoes*. Fats and oils are a source of essential fatty acids, *energy* and *fat-soluble* vitamins. *Meat*, *fish* and *eggs* are a source of proteins, calcium and vitamins. Minerals and ballast sub-

Table 8 – Prevention of some diseases with food products [3, 8 – 11]

Diseases	Food	Content of active (ballast) substances
Atherosclerosis	Oat flakes, rye bread	9,5% (14,1%)
Overweight	Bran products	(49,5 %)
Gallstone	Bread (buns) with bran	7 % (3,5 %)
Hemorrhoids	Apple, leaf salad	2,3 (1,6 %)
Colon polyps	Butter cookies (pasta)	1,5 % (1,5 %)
Irritation of the colon	Steamed rice	(0,6 %)

stances, vitamins, carbohydrates and to some extent proteins are contained in *vegetables* and *legumes*. And fruits have the highest content of vitamins, carbohydrates, ballast and mineral substances. Taking into account these features of the nutritional properties of various products, the diet should be as diverse as possible.

It is possible to reduce the content of fats in the blood, excess weight and the burden on the organs of digestion and vital activity by reducing dietary fats in the diet to 80 g per day. Including 40 g of cooking fats for self-use in their native form in the form of various sandwiches and 30-40 g hidden in sausages, pastries, mass, etc.

Since blood pressure is directly related to the consumption of salt, it is necessary to reduce its content in the diet as much as possible, limiting the daily norm to 5-7 g. You can compensate for the salt with a greater consumption of spices and greens.

Minimize consumption of sweets and sugary drinks to reduce blood sugar levels, risk of excess weight, tooth decay and nutrient deficiencies. And to compensate for the body's deficiency in nutrients, ballast and mineral substances, the proportion of whole grain products should be increased. The same applies to the consumption of fruits and vegetables as close as possible to their natural state.

In a complete diet, the amount and frequency of consumption of animal products should be limited. The Society recommends eating small portions of meat and sausages no more than twice a week. No more than three eggs per week. Compensate with dairy products, grain protein, legumes and potatoes.

Drink at least 1.5-2 liters of non-alcoholic liquids every day.

The penultimate rule applies to portioned meals, reducing daily portions by increasing them up to 5 times a day.

The last rule of the Society concerns the methods of cooking with *the help of economic culinary processing* of products in order to preserve as much of the nutrients as possible. Using stewing over low heat with minimal water content, steaming, etc.

In the industrialized countries of Western Europe, for a long time, especially in the last decade, they have been consistently justifying the reformation of the concepts of habitual nutrition, balanced *ecologically safe* and *healthy nutrition*. In the well-founded concept of healthy nutrition, the dominant share of *75%* falls precisely on cereals, potatoes, vegetables, fruits and dairy products. And in the list of meat products, it is advisable to increase the share of less energy-consuming and ecologically safer poultry farms. In the same Germany we mentioned above, it is not so far in the future, as by 2030 it is expected to increase the share of grain products with vegetables, fruits and dairy products in the human diet to 75%.

Conclusions:

1. According to its energy potential, plant products can fully provide the estimated need of mankind in food products, but more than half of them suffer from malnutrition.

2. Compared to vegetable products, animal products are several times more expensive and more ecologically dangerous.

3. By combining the native potential of plant food products and the anatomical components of their grains, it is possible to increase the nutritional value of mixtures, their social significance, and give them therapeutic and preventive properties.

4. The use of modern technological methods of in-depth processing and packaging of specified mixtures of grain components and livestock products can reduce energy and environmental risks to the environment.

5. The potential of domestic flour mills, groats and compound feed enterprises allows to produce grain products with given therapeutic and preventive properties.

REFERENCES

1. Zhemela H.P., Shemavnov V.I., Oleksiuk O.M. Tekhnolohiia zberihannia i pererobky produktsii roslynnytstva. Pidruchnyk. – Poltava: TERRA, 2003. 420 s.;
2. Podpriatov H. I. Skaletska L. F. Senkov A. M. «Zberihannia i pererobka produktsii roslynnytstva. – K.: Tsentr informatsiinykh tekhnolohii, 2010. 544 s.;
3. Gaby Hauber-Schwenk. Dtv-Atlas Ernahrung. Mit 82 Abbildungsseiten in Farbe Grafische Gestaltung / Gaby Hauber-Schwenk, Michael Schwenk // Deutcher Taschenbuch Vertag. TOV «Patent» Uzhhorod. 2004. 183 P.;
4. Pro osnovni pryntsypy ta vymohy do bezpechnosti ta yakosti kharchovykh produktiv: [zakon Ukrainy: vid 22 lypnia 2014 r. № 1602-VII]. Vidomosti Verkhovnoi Rady Ukrainy. 2014. – № 41. 42 s.;
5. Tekhnolohiia zberihannia i pererobky silskohospodarskoi produktsii: navch. posib. / Sytnikova N. O., Fomina K. F., Dudnyk L. I., Chornozubenko N. N., Kuzmenko L. I. Kyiv. Ahrarna osvita, 2008. 304 s.;
6. Shutenko Ye. I., Sots. S. M. Tekhnolohiia krupianoho vyrobnytstva: navch. posib. Kyiv: Osvita Ukrainy, 2010. 272 s.;
7. Roslynnytstvo z osnovamy tekhnolohii pererobky / Melnyk A. V., Trotsenko V.I., Zhatov O. H. ta in. Sumy: VTD "Universytetska knyha", 2008. 384 s.;
8. Bezpeka kharchuvannia: suchasni problemy: pidruchnyk / Babiuk A.V., Makarova O.V., Rohozynskyi M.S. ta in. Chernivtsi: Knyhy – XXI, 2005. 456 s.;
9. Bomba M.Ia. Ekolohichni aspekty pokrashchennia yakosti produktiv kharchuvannia // Novitni tendentsii u kharchovykh tekhnolohiiakh ta yakist i bezpechnist produktiv: zb. st. IV Vseukr. nauk.-prakt. konf. – Lviv: LIET, 2012. S. 10–17;
10. Mazur V.A., Tkachuk O.P., Yakovets L.A. Ekolohichna bezpeka zernovoi ta zernobobovoi produktsii. – Vinnytsia: VNAU. 2020. 442 s.;
11. Antiushko D. V. Osoblyvosti standartyzatsii v Ukraini ta sviti zerna pshenytsi. Doslidzhennia yakosti kharchovykh produktiv, 2007. № 1. S. 90-101;
12. Merko I.T., Morhun V.O. Naukovi osnovy i tekhnolohiia pererobky zerna. Pidruch. dlia stud. vyshch. navch. Zakladiv. – Odessa: Druk, 2001. 348 s.;

13. Hrek O. V., Krasulia O. O. Tekhnolohiia haluzi. Rozdil «Tekhnolohiia dytiachykh molochnykh produktiv»: laboratornyi praktykum dlia stud. napr. pidhot. 6.051701 «Kharchovi tekhnolohii ta inzheneriia» dennoi ta zaochnoi form navchannia / K.: NUKhT, 2015. 46 s.;
14. Haponiuk I.I. Laboratornyi praktykum «Problemy nauky pro zerno» dlia zdobuvachiv osvitnoho stupenia «Mahistr», spetsialnosti 181 «Kharchovi tekhnolohii» osvitno-profesiinoi prohramy «Tekhnolohii zberihannia i pererobky zerna» dennoi ta zaochnoi form navchannia / K.: NUKhT, 2019. 36 s.

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ПРОДУКТИ ПЕРЕРОБКИ ЗЕРНА В РАЦІОНАЛЬНОМУ ХАРЧУВАННІ ЛЮДИНИ

Анотація

У зв'язку з тим, що продукти рослинного походження широко використовується всіма контингентами населення і є обов'язковими в раціональному харчуванні завдяки значного вмісту вітамінів, мінеральних речовин, складних вуглеводів, специфічних речовин, тема їх застосування в раціональному харчуванні потребую ще більш ретельного вивчення. Також вона потребує уваги у зв'язку з тим, що лікарям важливо знати особливості складу і властивостей хліба, хлібобулочних, круп'яних виробів, бобових та інших продуктів переробки зерна, їх загальний та специфічний вплив на організм, доцільне поєднання можливості надання їм певних властивостей з допомогою прийомів дієтичної кулінарії для ефективного використання їх в раціональному, лікувальному, лікувально-профілактичному харчуванні. У статті розкриті поняття, зміст й вимоги до раціонального харчування людини з врахуванням особливостей потреб різних груп споживачів. Відмічено актуальність гармонізації структури харчування за енергетичною та якісною складовою зі змінами екологічного стану довкілля та загостренням морально-етичної чутливості суспільства до тваринницьких джерел харчування. Загострено увагу на зростаючій проблемі екологічної складової промислової індустрії продукції тваринницьких комплексів та пошуку компромісу в збільшені виробництва продуктів рослинного походження, розширені асортименту продуктів переробки зерна, вибіркового використання їх анатомічних складових та застосуванні технологій різної глибини їх обробки. Крім екологічної складової переваг продуктів рослинництва над тваринницькою, наведено також економічну та якісну доцільність цього. Зокрема відмічено, що вибірковим використанням різних анатомічних складових зернівки можна змінювати енергетичну цінність продуктів харчування в 1,5 – 2,0 рази, кількакратно – вміст в них вітамінів, мікроелементів та біологічно-активних складових, як ензими чи ферменти. До цього ж, застосуванням технологій поглибленої переробки, можна суттєво управляти поживною цінністю зернопродуктів, а саме кількакратним збільшенням вмісту декстринів чи крохмальних зерен, що клейстеризуються. Можливість комбінованого використання різних зернових культур у поєднанні із заданими технологіями їх поглибленої обробки дозволяє надавати продуктам профілактично-лікувальних властивостей. Відмічено позитивну тенденцію інтенсифікації вітчизняної зернової індустрії та зростання її наукового потенціалу. Саме тому, такі рослинні джерела харчування людини, як зернові продукти, у поєднанні з різними технологіями їх оброблення, доцільно використовувати для покриття дефіциту джерел продуктів тваринницького походження, послаблення негативного впливу діяльності тваринницьких господарств на екосистему планети, диференційованого використання в харчуванні споживачів з врахуванням особливостей активності їх життєдіяльності чи вікового стану, а також покращити доступність до продуктів харчування соціально вразливим верствам населення.

Ключові слові: зернопродукти, поживна цінність, якість, енергія, екологія, харчування, технології.

Received 28.08.2022 **Revised 22.09.2022**
Reviewed 10.09.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Gaponyuk I., Gaponyuk O., Goncharuk G. Grain processing products in rational human nutrition. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 33-39. DOI https://doi.org/10.15673/

Cite as State Standard of Ukraine 8302:2015
Grain processing products in rational human nutrition. / Gaponyuk I. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 33-39. DOI https://doi.org/10.15673/

Ukrainian LiveStock Summit 2022

UDC 664.641.612.3
DOI https://doi.org/10.15673/gpmf.v22i3.2460

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THE USE OF MILK THISTLE SEED FLOUR IN THE COMPOSITION OF YEAST DOUGH FOR CHEESE PASTRY

Abstract

One of the progressive directions in the development of the production of food products and culinary products is the creation of new flour products and giving them a functional focus by using natural ingredients. The biologically active complex of milk thistle flour contains vitamins, minerals and trace elements, prevents the accumulation of harmful substances in the human body and has a hepatoprotective effect. The article presents the results of research on the use of milk thistle seed flour in the technology of flour products from yeast dough - cheese pastry. The expediency of using milk thistle seed flour in the production of butter products, which was added to the mass of high-grade wheat flour in the amount of 3.0 to 5.0%, was established experimentally. A rational amount of thistle flour in the composition of the yeast dough was established, which is 5.0% by weight of wheat flour. The effect of thistle seed flour on the amount and quality of gluten in the dough was investigated, the effect of new raw materials on the properties of the dough and quality indicators of the finished product was established.

The addition of milk thistle seed flour to the composition of yeast dough for cheesecake has a positive effect on the nutritional value of the finished product, the amount of biologically active substances useful and necessary for the human body has increased: mineral elements, vitamins (vitamins E and group B), unsaturated fatty acids, as well as food fibers The feasibility of using milk thistle seed flour in the production technology of flour products from yeast dough to expand the range of flour products of increased biological value has been proven. The developed flour product using milk thistle flour can be introduced into restaurants as a functional product with increased nutritional value.

Keywords: milk thistle seed flour, butter products, nutritional value, semi-finished product, organoleptic evaluation, vitamins, antioxidants.

Introduction

Modern ecological conditions in our country and in the whole world are characterized by a wide spread of various diseases associated with insufficient content of important macroelements and microelements in the human body, with diseases of the gastrointestinal tract and others. Together with food, substances that have toxic and carcinogenic properties enter the human body. In this connection, there is an urgent need for additional sources of useful substances in the diet of the country's population.

Yeast dough products are one of the most popular

among the population and make up almost 45.0% of the assortment of flour products.For residents of Ukraine, bakery products, as well as products made from yeast dough, are products of daily use, which are a source of energy and nutrients for the human body. But the main disadvantage of these products is that their excessive consumption disrupts the balance of food rations in terms of nutritional and energy value. This is explained by the high content of fats and carbohydrates (starch, oligosaccharides), low content of minerals, vitamins and dietary fibers. Therefore, one of the progressive directions in the production of food products is the creation of new flour products and giving them a functional focus by using natural ingredients.

One of the promising ways to solve this problem is the enrichment of flour products from yeast dough with additives of plant origin, obtained from agricultural crops and not previously used in the technology of products from yeast dough [1,2].

Processing of semolina and production of flour from it is one of the directions of development of the industry that produces vegetable oils. It is the meal that contains the remaining portion of oil and other nutrients and biologically active substances. The use of flour from oilseed meal in the production of flour products from yeast dough allows to enrich the chemical composition of products with protein and lipids, to create functional products.

Adding substances that have a hepatoprotective effect to the recipe of flour products from yeast dough is also gaining relevance. Hepatoprotectors - agents that increase the resistance of liver cells to the action of damaging factors, activate its detoxification functions and increase the activity of metabolic processes, improve the functional state of the liver.

Milk thistle seed flour, based on its functional properties, biological value and chemical composition, belongs to products that prevent the accumulation of harmful substances in the human body and have Milk thistle - Silybum marianum (L.) Gaertn - a strong hepatoprotector. Since ancient times, it has been used as a medicinal plant for the treatment of liver diseases. Milk thistle contains the flavolignan silymarin, which has a hepatoprotective effect. The most valuable component of this plant is the seed, which includes flavolignans, the main ones of which are silybin (silymarin), silydianin, silychristin, in addition, the seed contains 32.0% fatty oil, a small amount of essential oil (0.08%), resins, mucilage, and also biogenic amines (thiamine, histamine) and about five flavonoids (taxifolin, quercetin, dehydrokaempferol, etc.), glucose, fructose, rhamnose, xylose, arabinose, galacturonic acid, amino acids, hydroxycinnamic acids, vitamins K, A, E, saponins, tannins, as well as macroelements K (9.2 μg/g), Ca (16.6 μg/g), Fe (0. 08 μg/g) and trace elements Al, Mg, Mn (0.1 μg/g), Cu (1.16 μg/g), Zn (0.71 μg/g), Cr (0.15 μg/g), Se (22.9 μg/g) , V (0.01 μg/g), Sr, Pb. The leaves of milk thistle contain flavonoids [3].

The high content of polyunsaturated fatty acids, dietary fibers, a wide range of minerals, vitamins E and group B, flavonoids in the composition of milk thistle seeds determines the prospects of its use in the production of yeast dough products.

Taking into account the wide range of functional properties of the studied raw materials and the wide interest in their use in the production of food products, the use of thistle seed flour in the production of buttery flour products is an actual direction of using raw materials of local importance to increase the nutritional value of buttery products that have wide popularity and mass consumption.

Literatury review

In the production technology of flour products, in order to reduce the calorie content and increase the biological value, wheat flour is replaced in recipes with chickpea, flax, triticale, sorghum, rice, barley, corn and others. Meals from non-traditional types of raw materials containing dietary fiber are added to the recipe of flour products. Gluten-free therapeutic and preventive products with functional properties are being developed for people with celiac disease.

Analyzing literary sources, we came to the conclusion that there are a number of separate technologies of food products with the use of milk thistle processing products and other plant raw materials.

A. V. Antonenko developed the technology of confectionery products from shortbread using a composition of soybean, sunflower, and thistle meal to obtain functional products with increased biological value [4].

N.V. Novgorodska, A.M. Solomon, I.M. Bernyk developed a recipe for chopped meat semi-finished products. From the conducted experiments, it was established that from a technological point of view, it is most optimal to add thistle meal to the meat system in the amount of 5.0% of the beef mass at the stage of making minced meat. At the same time, the functional and technological properties of the meat system improve, and the organoleptic indicators do not deteriorate [5].

L.A. Mykhonik, A.M. Hryshchenko developed the technology of bread from wheat whole grain flour using meal from thistle seeds. The effect of meal on the amount and quality of gluten in the dough was investigated. The indicators of the technological process and quality of bread made from wheat whole-grain flour with different dosages of thistle seed meal are given. Taking into account the valuable chemical composition, the high content of antioxidants, the use of this raw material made it possible to expand the assortment of bread products for health and preventive purposes [6].

N.P. Buyalska, O.L. Gumenyuk, N.M. Denisova, and V.M. Chelyabiev proved in their work that the use of thistle processing products in the production of bakery products in order to increase the quality, nutritional value and give them health-promoting properties is expedient, scientifically based and experimentally confirmed. It was found that the most optimal is the use of 2.0% milk thistle meal and 6.0% milk thistle oil as an additive to the mass of flour. The use of meal accelerates the fermentation process and improves the lifting power of yeast, which has a positive effect on the physical and chemical indicators of the quality of finished products. Bread with the addition of milk thistle processing products has better organoleptic and physicochemical properties compared to the control sample [7].

Yana Bachynska investigated the impact of using non-traditional plant raw materials in the production of flour confectionery products with increased biological value. The paper presents the results of the commodity evaluation of the developed products and compares them with the main samples presented in the retail network of Kharkiv. The expediency of using a mixture of dietary fibers and meal from pumpkin seeds as natural plant additives in the production technology of flour confectionery products has been proven [8].

By Veronika Bortikova, Lucas Kolaris and others. [9] established the expediency of using thistle seed flour in the production of cookies. In the course of experiments, the effect of replacing wheat flour on the technological properties of the dough, the change in the water absorption capacity of the flour and the stability of the dough was studied.

Scientists Shahat Mohamed S., Hussein Ahmed S., Hady Essam A. developed the technology of baladi bread using defatted thistle seeds for the treatment and prevention of liver diseases [10]. The therapeutic effect of this product with the addition of thistle seeds was proven during an experiment conducted on rats.

We believe that such a problem as an unfavorable environmental situation, the introduction of substances from the environment that have a toxic and carcinogenic effect, requires the introduction of new functional products into production, in particular flour products from yeast dough, which have a hepatoprotective effect and increased nutritional value. Therefore, the use of non-traditional plant raw materials, namely milk thistle seed flour as part of a yeast semi-finished product for the production of cheesecakeis interesting and relevant.

The purpose and tasks of the research

The purpose of the study is to expand the range of buttery flour products by using milk thistle seed flour to increase the nutritional value of the products and provide them with a functional purpose.

To solve the goal, it is necessary to establish the dosage of thistle seed flour for the preparation of the product and to study the peculiarities of its use, to determine its influence on the technological process, to investigate the change in the organoleptic and physicochemical quality indicators of the semi-finished product and the finished product, to determine the nutritional value and mineral composition of the developed product.

Research materials and methods

The research materials were: the raw material included in the recipe for biscuits with jam, thistle seed flour, produced by the company "BioRaztorpsha", semi-finished dough and finished product.

During the work, standard, generally accepted research methods were used.

Selection and preparation of samples was carried out according to the current standards for bread and bakery products - DSTU 7044:2009. The mass fraction of moisture was determined using Chizhova's device, porosity was determined organoleptically, dimensional stability of the products was determined as the ratio of the height of the product to its diameter. Determination of crude gluten content was carried out in accordance with DSTU ISO 21415-1:2009 Wheat and wheat flour gluten content. Determination of crude gluten manually [8]. The moisture absorption capacity of the flour was determined by the centrifugation method according to the standard method, the acidity of the dough was determined by the titrometric method, the mineral composition and nutritional value of the new products were determined by the calculation method. Tasting analysis of finished products was carried out by scoring samples.

Research results and their discussion

The dough for cheese pastry was prepared using a steam method, and pastry with jam No. 1098 according to the collection of recipes using high-grade wheat flour were used as a control sample.

Spotted milk thistle flour was added to test samples in the amount of 3.0 when kneading the dough; 5.0; 7.0% to the mass of wheat flour in the dough, samples No. 1, No. 2 and No. 3 were formed, respectively. The fermentation temperature of the dough was +29...32°C. The control sample was dough without the addition of thistle seed flour.

The content of milk thistle seed flour in the composition of the yeast semi-finished product for the production of cakes with jam was substantiated by an experimental method. The effect of thistle seed flour on the organoleptic parameters of the puff pastry and the physicochemical properties of the dough was determined.

The obtained data showed that the content of gluten in experimental samples No. 1, No. 2, and No. 3 decreased in comparison with the control sample, respectively, by 1.7%, 2.7%, and 3.3%, but it is within the normative values (for high-grade flour - not less than 24.0%). The decrease in gluten content is most likely due to the introduction of flour from milk thistle seeds, the proteins of which are not capable of its formation. The quality of gluten in the samples with flour from milk thistle seeds in test samples No. 1, No. 2 and No. 3 also changed, the extensibility decreased slightly, the elasticity of the gluten is good, the color is light with a cream shade. The obtained results correspond to the data of the authors' study [6], who established that the addition of thistle meal affects the quantity and quality of gluten, namely, with an increase in the dosage of the studied raw material, the amount of raw and dry gluten decreases, and its quality changes. The results of assessing the amount and quality of gluten in the dough with the addition of different amounts of thistle seed flour in comparison with the control sample are presented in Table 1.

To determine the influence of flour from thistle seeds on the quality of the dough and the finished product, the baking of cheese pastry was carried out. Preparations from fermented yeast dough were subjected to development and curing at an air temperature of 32...35°C and a relative humidity of 75...83%. The duration of baking was 18-22·60 s at a temperature of +210...220°C. The baking properties of the recipe mixtures were evaluated by the quality of the finished

Table 1 – Evaluation of the quality of samples with the addition of different amounts of thistle seed flour

Name of indicators	Variants of the ratio of wheat flour and milk thistle seed flour			
	Control sample (100:0)	Sample 1 (97:3)	Sample 2 (95:5)	Sample 3 (93:7)
Water absorption capacity, %	57.0	59.0	61.0	65.0
Gluten content, %	30.0	29.5	29.2	29.0
Elasticity	good	good	good	good
Extensibility, see	19.0	18.0	17.0	16.5

Table 2 -Acidity dough with the addition of thistle flour

Name of indicators	Variants of the ratio of wheat flour and milk thistle seed flour			
	Control sample (100:0)	Sample 1 (97:3)	Sample 2 (95:5)	Sample 3 (93:7)
Initial acidity of the dough, degrees	2.0	2.0	2.0	2.0
Final acidity of the dough, degrees	3.2	3.5	3.7	3.9

bakery products obtained by trial baking.

In the process of research, it was established that the acidity of the dough in the samples with the addition of milk thistle seed flour after fermentation was higher than in the control sample, this indicates an increase in the intensity of fermentation and contributes to a slight reduction in the duration of the fermentation of the dough. The acidity of the dough in samples with the addition of different amounts of thistle flour is presented in Table 2.

The organoleptic evaluation of the quality of the samples of cheesecakes with the addition of different amounts of thistle seed flour was carried out by means of a point evaluation of the studied samples. The results of the tasting analysis are presented in Table 3.

As a result of the organoleptic evaluation, it was established that according to the main indicators, test samples No. 1 and No. 2 with the introduction of 3.0% and 5.0% flour of milk thistle seeds, respectively, had no significant differences. Vatrushki from the above-mentioned samples had an attractive appearance, pleasant taste and aroma. Sample No. 3 with the introduction of 7.0% milk thistle seed flour differed from the control product by a darker color of the surface of the product and the presence of an extraneous bitter aftertaste.

Thus, when using milk thistle seeds to the mass of wheat flour of the highest grade, it should be considered rational to add thistle flour in the amount of 3.0 to 5.0% of the mass of wheat flour. At the same time, the cheesecakehas an attractive appearance, a correct shape, a smooth surface, a pleasant taste and aroma, a uniform, thin-walled structure of porosity, and a well-formed pulp. The color of the pulp of the finished product is light with a slight grayish tint.

The results of the assessment of the physical and chemical parameters of the finished products are presented in Table 4.

Table 4 – Physico-chemical indicators of the quality of finished products

Characteristic	Adding flour from thistle seeds to the composition of cottage cheese			
	Control 0%	Sample 1 3.0%	Sample 2 5.0%	Sample 3 7.0%
Mass fraction of moisture, %	38.5	38.6	38.8	39.0
Form retention, N/A	0.3	0.3	0.3	0.3

Table 3 – Results of the tasting analysis of organoleptic parameters of new products

Characteristic	Evaluation of the indicator for the content of new raw materials in the composition of culinary products, %			
	Control	Sample 13.0%	Sample 25.0%	Sample 37.0%
Appearance	5	5	4	4
Color	5	5	5	4
Scent	5	5	5	5
Taste	5	5	5	3
Porosity	5	5	4	4
Overall assessment	25	25	23	20

According to the results of the conducted research, we can see that when adding 3.0% flour of milk thistle seeds to the mass of wheat flour (sample No. 1), no changes occurred. The porosity of the cheese pastry was at the level of the control sample, the moisture content was within the limits set by the standard (for butter products, the mass fraction of moisture is 37.0 - 45.0%), the dimensional stability of the sample was at the control level. When adding 5.0% milk thistle seed flour to the mass of wheat flour (sample No. 2), the moisture content increases by 0.8%, and the dimensional stability of the sample is at the control level. When adding 7.0% milk thistle seed flour to the mass of wheat flour (sample No. 3), the moisture content increases by 1.2%, the dimensional stability remains at the control level.

Therefore, the analysis of the obtained data shows that the replacement of a part of wheat flour in the composition of butter products with thistle seed flour affects the quality of the semi-finished dough and the finished product, changes the organoleptic indicators of the product and requires the adjustment of the technological process to obtain a new high-quality product.

Table 5 - Comparative characteristics of the nutritional value of cheese pastry

The name of the nutrient	Content, g/100 g of product	
	cheesecakes with jam N. 1098	cheesecakes with the addition of thistle flour
Squirrels	4.7	5.1
Fats	11.5	12.02
Carbohydrates	37.6	37.8
Food fibers	1.1	1.37
Organic acids	23.8	23.8
Flavonoids, %	-	0.04
Calorie content, kcal	262.5	265.5

Table 6 - Comparative characteristics of the vitamin composition

The name of the nutrient	Content in 100 g of product	
	cheesecakes with jam N.1098	cheesecakes with the addition of thistle flour
A, RE	2.9 mcg	2.9 mcg
B1, thiamine	0.73 mg	0.73 mg
B2, riboflavin	0.87 mg	0.9 mg
B4, choline	18.05 mg	18.05 mg
B5, pantothenic acid	0.36 mg	0.36 mg
B6, pyridoxine	0.08 mg	0.08 mg
B9, folates	40.47 mcg	40.47 mcg
B12, cobalamin	0.07 mcg	0.07 mcg
C, ascorbic	0.24 mg	0.24 mg
D, calciferol	0.01 mcg	0.01 mcg
E, alpha tocopherol, TE	5.13 mg	6.1 mg
H, biotin	2.82 mcg	2.82 mcg
RR, NE	1.84 mg	1.84 mg
β-carotene	-	0.03 mg

Taking into account the high biological value of the researched raw material and its functional value, the next stage of the work was the determination of the nutritional value, vitamin and mineral composition of cheese pastry with the addition of thistle flour in a ratio of 95:5 (wheat: milk thistle) in comparison with the analogue. Comparative characteristics are given in tables 5, 6, 7.

The analysis of the obtained data from the calculation of the main food nutrients and biologically active substances shows that the replacement of wheat flour with thistle seed flour in the amount of 5.0% contributes to a slight increase in the content of proteins (by 8.5%), fats (by 4.5%) and a significant increase in the content of dietary fibers (by 24.5%), the calorie content of the product does not change. In addition, the amount of antioxidant vitamins (tocopherol and β-carotene) increases in the cheese pastry with the addition of the

Table 7 - Comparative characteristics of the mineral composition of cheese pastry

The name of the nutrient	Content in 100 g of product	
	cheesecakes with jam N. 1098	cheesecakes with the addition of thistle flour
Macroelements		
Kaliy, K	97.98 mg	97.98 mg
Calcium, Ca	54.73 mg	59.3 mg
Silicon, Si	1.083 mg	1.083 mg
Magnesium, Mg	8.88 mg	10.2 mg
Sodium, Na	15.23 mg	15.23 mg
Syra, S	24.69 mg	24.69 mg
Phosphorus, P	63.4 mg	64.4 mg
Chlorine, Cl	371.7 mg	371.7 mg
Microelements		
Bohr, B	9.9 mcg	9.9 mcg
Vanadiy, V	24.12 mcg	24.12 mcg
Iron, Fe	0.95 mg	1.2 mg
Iodine, I	2.17 mcg	2.17 mcg
Cobalt, Co	0.65 mcg	0.65 mcg
Manganese, Mn	0.41 mg	0.41 mg
Copper, Cu	49.03 mcg	49.03 mcg
Molybdenum, Mo	5.271 mcg	5.271 mcg
Selenium, Se	1.95 mcg	1.949 mcg
Fluoride, F	9.24 mcg	9.24 mcg
Chrome, Cr	0.94 mcg	0.94 mcg
Zinc, Zn	0.33 mg	0.33 mg

studied raw materials, the content of calcium, magnesium and iron increases, and the developed product contains flavonoids and flavolignans.

Conclusions

Thus, research shows thataccording to a complex of organoleptic and physicochemical indicators dough and finished producta recipe for cheese pastry using milk thistle flour was developed, the effect of the addition of new raw materials on the quantity and quality of gluten, acidity of the dough, quality and nutritional value of the finished products was determined. It was established that, from a technological point of view, it is most rational to add thistle seed flour to the yeast dough in the amount of 5.0%, replacing wheat flour. At the same time, the organoleptic indicators of the quality of the finished product remain at the control level, the functional and technological properties of the dough change (the acidity of the fermented dough increases), the nutritional and biological value of the product increases. The developed flour product from yeast dough using milk thistle seed flour can be implemented in restaurants as a functional product with increased nutritional and biological value.

REFERENCES

1. Mazaraki, A.A. Technology of functional food products / A. A. Mazaraki, editor. M. I. Peresichny // 2nd ed., revised. and added Monograph K.: Kyiv. national trade and economy University, 2012. – 1116 c.
2. Kaprelyants, L.V. Functional products: Trends and perspectives / L.V. Kaprelyants, G.A. Khomych // Food science and technology - 2012. - No. 4. - p. 5.

3. Medicinal plants: Encyclopedic guide. K.: "Ukrainian Encyclopedia" named after M. P. Bazhana. 1992. 544 p.
4. Antonenko A.V., V.S. Mykhailik Technology and quality of cookies with oilseed meal. Food science and technology. Volume 10 Issue 1 / 2016. p. 72-76.
5. Novgorodska N.V., Solomon A.M, Bernyk I.M. Evaluation of the quality of minced meat systems using vegetable raw materials. Feed the resources. Vol. 9 (2021), No. 17, pp. 119-128.
6. Mykhonik, L.A. The use of meal from thistle seeds in the technology of bread from wheat whole grain flour/ L. A. Mykhonik, A. M. Hryshchenko // Storage and processing of grain. – 2017. - No. 3 (211) - P. 40-43.
7. Buyalska N.P., O.L. Humenyuk O.L., Denisova N.M., Chelyabiyeva V.M. Increasing the nutritional value of bakery and flour confectionery products: monograph – Chernihiv: ChNTU, 2020. – p. 122.
8. Yana Bachynska. The use of non-traditional raw materials in the production of flour confectionery as a progressive direction of creating products of increased biological value. Traektoriâ Nauki www.pathofscience.org International Electronic Scientific Journal. 2017. Vol. 3, No. 2.
9. Veronika Bortlíková, Lukáš Kolarič, Peter Šimko. Application of milk thistle (Silybum marianum) in functional biscuits formulation. Acta Chimica Slovaca, Vol. 12, No. 2, 2019, pp. 192—199, DOI: 10.2478/acs-2019-0027
10. Shahat Mohamed S., 2Hussein Ahmed S. and 1Hady Essam A. Preparation of Bread Supplemented with Milk Thistle Flour and its Effect on Acute Hepatic Damage Caused by Carbon Tetrachloride in Rats.Middle East Journal of Applied Sciences Volume 06, Issue 03, 2016, pp. 531-540
11. Technochemical control of raw materials and bakery and pasta products: study guide / edited by member-cor. V.I. Drobot - K.: Condor Publishing House, 2015.− 958 p.

УДК 664.641.612.3

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ВИКОРИСТАННЯ БОРОШНА НАСІННЯ РОЗТОРОПШІ ПЛЯМИСТОЇ У СКЛАДІ ДРІЖДЖОВОГО ТІСТА ДЛЯ ВАТРУШОК

Анотація

Одним із прогресивних напрямків розвитку виробництва харчової продукції та кулінарних виробів є створення нових борошняних виробів і надання їм функціональної спрямованості шляхом застосування натуральних інгредієнтів. Біологічно активний комплекс борошна розторопші плямистої містить вітаміни, мінеральні речовини і мікроелементи, запобігає накопиченню шкідливих речовин в організмі людини та володіє гепатопротекторним ефектом. У статті наводяться результати досліджень використання борошна насіння розторопші плямистої у технології борошняних виробів із дріжджового тіста - ватрушок. Дослідним шляхом встановлено доцільність використання борошна насіння розторопші плямистої у виробництві здобних виробів, яке вносили до маси пшеничного борошна вищого сорту у кількості від 3.0 до 5.0%. Встановлено раціональну кількість борошна розторопші у складі дріжджового тіста, яка складає 5.0% до маси пшеничного борошна.

Досліджено вплив борошна насіння розторопші на кількість та якість клейковини в тісті, встановлено вплив нової сировини на властивості тіста та показники якості готового виробу.

Додавання до складу дріжджового тіста для ватрушок борошна насіння розторопші плямистої позитивно вплинуло на харчову цінність готового виробу, підвищилася кількість корисних і необхідних людському організму біологічно-активних речовин: мінеральних елементів, вітамінів (вітамінів Е та групи В),ненасичених жирних кислот, а також харчових волокон. Доведена доцільність використання борошна насіння розторопші плямистої в технології виробництва борошняних виробів із дріжджового тіста для розширення асортименту борошняних виробів підвищеної біологічної цінності.

Розроблений борошняний виріб з використанням борошна розторопші може бути впроваджений у заклади ресторанного господарства, як функціональний виріб з підвищеною харчовою цінністю.

Ключові слова: борошно насіння розторопші плямистої, здобні вироби, харчова цінність, напівфабрикат, органолептична оцінка, вітаміни, антиоксиданти.

Received 09.08.2022 **Revised 22.03.2022**
Reviewed 17.01.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Melnyk O., Marenkova T., Koshel O. The use of milk thistle seed flour in the composition of yeast dough for cheese pastry. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 40-45. **DOI** https://doi.org/10.15673/gpmf.v22i3.2460

Cite as State Standard of Ukraine 8302:2015
The use of milk thistle seed flour in the composition of yeast dough for cheese pastry. / Melnyk O. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 40-45. **DOI** https://doi.org/10.15673/gpmf.v22i3.2460

UDK 621.876.113
DOI https://doi.org/10.15673/

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DEVELOPMENT OF THE SCHEME OF THE RIGGING AND ASSEMBLY INSTALLATION

Abstrakt

In the conditions of reconstruction or technical re-equipment of grain storage and processing enterprises, there are cases of absence or impossibility of using the necessary universal lifting and transport means, in particular, construction tower or self-propelled jib cranes at the installation sites. In such situations, they resort to the construction of specialized rigging and installation installations, which are based on the use of rigging and installation mechanisms, rigging devices and rigging equipment. The given sequence of actions, definitions and calculations at the same time practically excludes the adoption of unfounded and erroneous decisions. Most often, such installations are located near the facade walls of buildings, equipped with installation slots and loading and receiving platforms, hoists and cargo winches. Choose the design, location and means of fastening the mounting beam or boom. The load capacity of the winch, from among those in the distribution, is specified and accepted. Determine the required multiplicity of the hoist, its efficiency, the amount of tensile and breaking forces in the load rope. Choose the type and diameter of the rope, as well as its length. Determine the rope capacity of the cargo winch drum and specify its technical characteristics. Choose the location and method of securing the winch. If necessary, calculate the mass of the ballast counterweight. Choose the location and method of attachment of the diverter block, determine the amount of force exerted by this block on the building structure or anchor. Choose the type of anchor and, if necessary, calculate its stability. If it is necessary to pull the load from the front wall of the building or structure, calculate the pulling force and choose the necessary winch or hoist for this. The effort to pull the cargo from the receiving platform into the premises and the technical means required for this are determined.

Keywords: installation; rigging; arrow; polyspast; load rope; winch.

Introduction

In the conditions of reconstruction or technical re-equipment of enterprises of the industry, there are cases of absence at the installation sites of universal lifting vehicles, in particular, construction tower cranes with a load capacity of 1.5 ... 50 t and a hook lifting height of up to 45 m.

The limited size of the installation site at such facilities sometimes also makes it impossible to use self-propelled jib cranes - automobile, crawler or pneumatic wheel cranes [1].

In similar situations, they resort to the construction of specialized rigging and installation installations, which are based on the use of rigging and installation mechanisms, rigging devices and rigging equipment [2,3].

Research results and their discussion

A generalized diagram of such an installation is shown in Fig. 1. The sequence of scheme development should be as follows.

1. Determine the maximum height H_{MAX}, m to which, according to the project or technical task, lifting of equipment and metal structures is provided.

2. Specify the cargo and dimensional characteristics of the equipment and metal structures that will be lifted by the installation under development: determine the load of maximum mass - M_{MAX}, kg and weight - Q_{MAX} (it is obvious that Q_{MAX} = g M_{MAX} , H), as well as maximum dimensions - length, width and height; taking into account the maximum width and height of the goods that must be delivered to each floor, determine the dimensions of the mounting slots necessary for this in the structural elements of buildings and structures, and the length is taken into account during the development of load slinging schemes and the selection of the necessary load-holding devices (slings, grabs or traverses).

3. Depending on this, as well as taking into account the features of the location and design of the neighboring buildings and structures closest to the installation object, choose the design, location and means of fixing the mounting beam or mounting boom (Fig. 2).

If necessary, perform a calculated check of the strength of the selected elements under the expected operating conditions.

The strength condition of a two-support beam (Fig. 2, a) or a fixed cantilever beam (Fig. 2, b) is written as follows

$$\sigma_3 \le [\sigma_3], \qquad (1)$$

where σ_3 and $[\sigma_3]$ are valid and permissible bending stress in the beam or beam material, Pa.

In turn, the actual bending stress is equal to

$$\sigma_3 = \frac{M_3}{W}, \text{ Pa} \qquad (2)$$

where M_3 is the bending moment acting on the beam or beam, N m; W is the moment of resistance of the cross section of the beam or beam, m^3.

The bending moment acting on the two-support beam is equal to

$$M_{3Б} = \frac{1}{4}(Q_{MAX} L_Б) + \frac{1}{8}(q_1 L_Б^2), N \cdot m \qquad (3)$$

where $L_Б$ is the distance between supports (length of the beam), m;

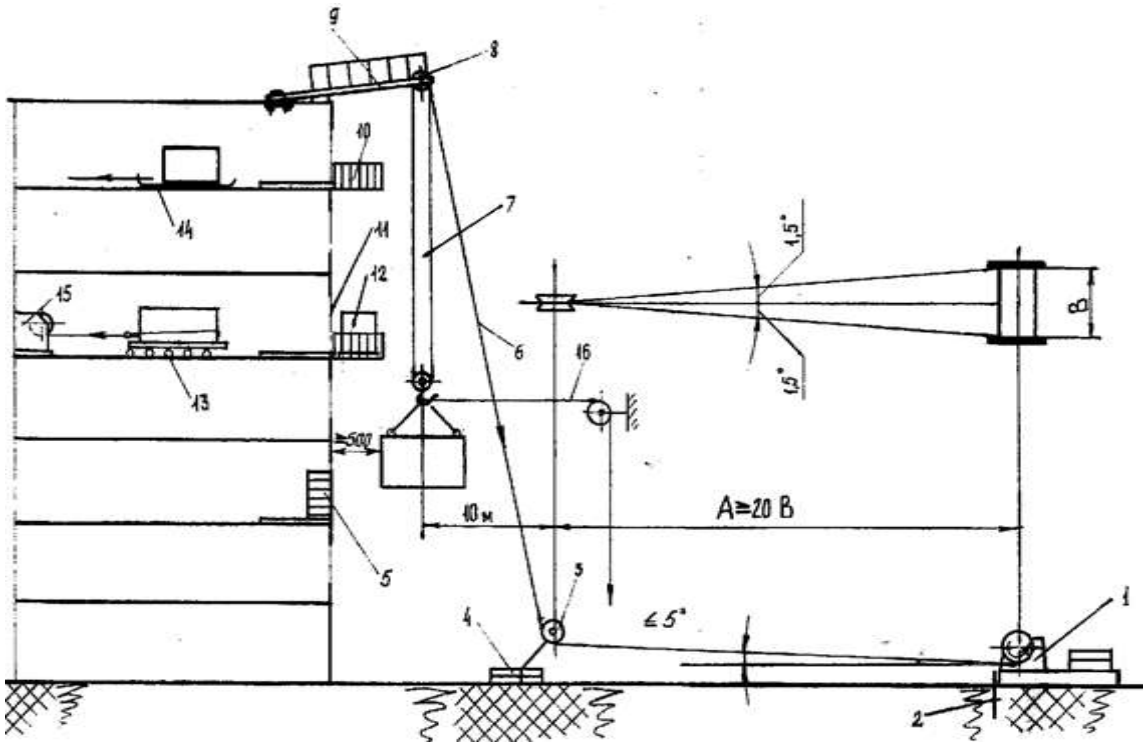

Fig. 1 – Scheme of the rigging installation: 1 – cargo winch; 2 – fuel-type anchor; 3 – outlet block; 4 – ground (ballast) type anchor; 5 – cargo receiving platform in a raised (non-working) state; 6 – descending branch of cargo rope; 7 – freight hoist; 8 – fixed block; 9 – cantilever boom; 10 – loading platform in lowered (working) condition; 11 – mounting slot; 12 – wattage at the cargo receiving platform; 13 – skating rinks; 14 – steel sheet; 15 – manual winch; 16 - brace.

For example, formulas (1), (2) and (4) are given for cantilever beams, which, after transformations, provide the determination of the required cross-section height

I-beams h_d

$$h_d \geq \sqrt[3]{\frac{51 Q_{MAX} L_C}{[\sigma_3]}} \text{ -0,02, } m \qquad (5)$$

or h_{III} channels: as single $h_{ш(од)}$

$$h_{ш(од)} \geq \sqrt[3]{\frac{81 Q_{MAX} L_C}{[\sigma_3]}} \text{ - 0.05 , } m \qquad (6)$$

and double $h_{ш(здв)}$

q_1 is the force of the weight of one meter of the beam, N/m (it is obvious that q_1 = 9.81 m_1, where m_1 is the mass of one meter of the beam, kg).

The bending moment acting at the end of the cantilever boom is equal to

$$M_{3C} = Q_{MAX} L_C , \ N \cdot m \qquad (4)$$

where L_C is the departure of the arrow, m

The moment of resistance - W - depends on the shape and dimensions of the cross-section of the beam or beam and is subject to calculation by conventional methods. Since I-beams and channels (single or double) are often used for the manufacture of beams and beams, below are empirical formulas for calculating the approximate values of moments of resistance of these sections

$$W_d \approx \frac{1}{51}(h + 0{,}02)^3 \ m^3 \text{ and } W_{ш} \approx \frac{1}{81}(h + 0{,}05)^3 , \ m^3$$

where h is the height of the corresponding section, m.

It is obvious that the design determination of h dimensions is also possible if the permissible stress - $[\sigma_3]$ - in the material of the beams or beams is taken as known.

$$h_{ш(здв)} \geq \sqrt[3]{\frac{81 Q_{MAX} L_C}{2[\sigma_3]}} \text{ - 0.05 , } m \qquad (7)$$

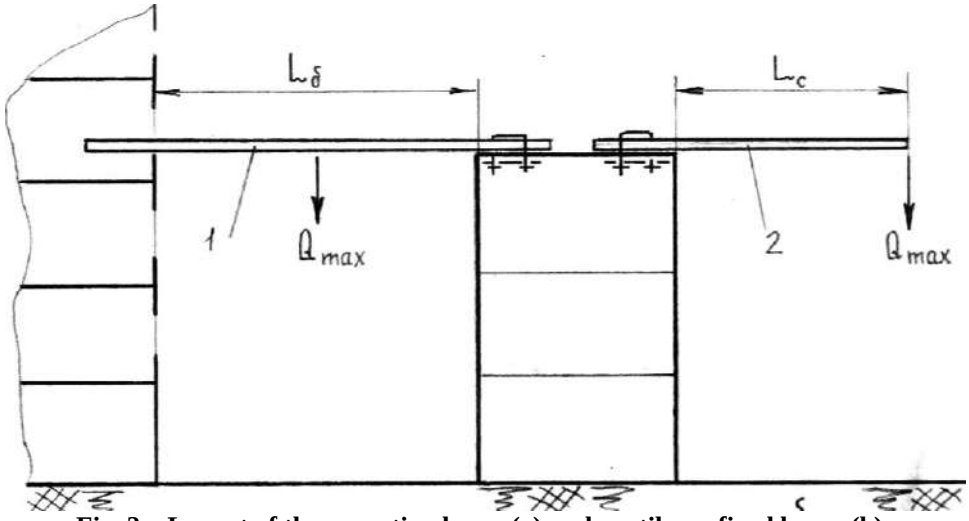

Fig. 2 – Layout of the mounting beam (a) and cantilever fixed boom (b): 1 – two-support beam; 2 – cantilever fixed boom.

4. Specify the load capacity of winches – P_W, which are available (in the conditions of real construction) or provided for in the technical task, and accept P_W, N.

5. If $Q_{MAX} > P_W$, then the required polyspast multiplicity is roughly determined by the expression

$$n = \frac{Q_{MAX}}{P_{TП}}, \quad (8)$$

where $P_{TП}$ is the pre-accepted effort in the descending branch of the cargo rope, H (take $P_{TП} \le P_W$). The found value of n should be rounded to the nearest whole number, which should not go beyond the interval 2 ... 10.

After that, the efficiency coefficient of polyspast is determined, which is equal to

$$\eta = \frac{1}{nk^n}\frac{k^n - 1}{k - 1}, \quad (9)$$

where k is the resistance coefficient of the roller bearing support (for a block with rolling bearings k = 1.03, and with sliding bearings k=1.04).

The specified value of the traction force - P_T - is determined after the appropriate transformations of the expression (8)

$$P_T = \frac{Q_{max}}{n \cdot \eta \cdot \eta_{вб}^m}, N \quad (10)$$

where η and $\eta_{вб}^m$ are the efficiency coefficients of the cargo hoist and diverter unit (at k = 1.03 η or $\eta_{вб}^m$ = 0.97, and at k=1.04 η or $\eta_{вб}^m$ = 0.96);

m is the number of lead-off blocks (under the conditions provided in Fig.1, m = 1).

6. According to the values of the found traction force - P_T - and the safety factor - ε = 5 ... 6, determine the breaking force of the cargo rope

$$P_K \ge P_T \varepsilon, \ N. \quad (11)$$

7. After that, the type and diameter - d - of the steel wire rope with the calculated breaking force is selected from the standard

$$Pкр \ge Pк. \quad (12)$$

8. Determine the diameter of the rollers of polyspast blocks - D, focusing on the ratio

$$\frac{Д}{d} \ge (e - 1), \quad (13)$$

where $Д$ is the block roller diameter, measured along the bottom of the groove, mm;

d – rope diameter, mm;

e is a coefficient, the value of which depends on the type of lifting machine and its mode of operation (for cargo winches with machine drive and mode of operation: light - e = 20, medium - e = 25 and heavy - e = 30).

Note: The easy mode is characterized by the operation of the rope at low speeds, without jerks, with the number of bends on the rollers no more than four; heavy - by the work of the rope at high speeds with jerks and the number of bends on the rollers is more than four [4].

9. Determine the length of the cargo rope - L - for equipping the rigging installation (together with the hoist)

$$L = n\,(H + 0{,}5\,\pi Д) + \ell + m_Б \pi Д_Б, \ m \quad (14)$$

where H is the distance from the axis of the upper, stationary block of the hoist to the axis of the lower, mobile one, when it is in the lowest position, that is, it touches the ground, m;

ℓ - the length of the descending branch of the cargo rope from the upper block of the hoist to the cargo winch, m, which is taken on the basis of the dimensions indicated on the diagram of the installation being developed;

$m_Б$ - the minimum allowable number of turns of the rope, which remains on the rope receiving drum with a diameter of $Д_Б$, when the movable block of the hoist touches the ground ($m_Б \ge 1.5$).

It is clear that $H = H_{MAX} + H_П$,

where $H_П$ is the length of the polyspast in the tightened state, which depends on its carrying capacity (for example, with a carrying capacity of 10 t $H_П$ = 2.6 m, with a carrying capacity of 25 t $H_П$ = 3.7 m). The carrying capacity of the polyspast is $10^{-3}.\frac{Q_{max}}{g}$, tons.

10. Determine the rope capacity of the drum of the cargo winch - L_K, which is equal to the length of the rope that must be wound on the drum during the lifting of the moving block to a height of H_{MAX}, i.e.

$$L_K = n\,H_{MAX}, \ m. \quad (15)$$

Taking into account the found value of L_K, specify the technical characteristics of the selected winch, in particular, the length of the drum - B, m (Fig. 1).

11. Determine the effort on the part of the diverter block - SBB - on the building structure or anchor by the expression

$$S_{ВБ} = 2P_T \cos\frac{\psi}{2}, \ N \quad (16)$$

where ψ is the angle between the directions of the sections of the descending branch of the cargo rope before and after it wraps around the lead-off block, degrees.

The location of the lead-off block is shown in fig. 1. The distance of the axis of the block from the front wall of the building is taken as close10 m.

12. Taking into account the value of $S_{ВБ}$, solve the issue of the means of fixing the lead-off block, choose the type of anchor and, if necessary, calculate its parameters according to the known method. At the same time, they are guided by the data in Table 1.

13. Choose the location of the cargo winch. The distance between the axes of the take-off block and the

Table 1 – Stability of anchors buried in the ground [1]

Constructive implementation of the anchor		Resistance, or the maximum force perceived by the anchor, kN
In the form of one wooden pile		to 20
In the form of two successively located wooden piles, connected to each other		up to 50
-"- -"- three -"- -"-		up to 100
Inventory anchor rod type		up to 120
Pit anchors type	Horizontal	up to 150
	Fuel-shield	up to 220

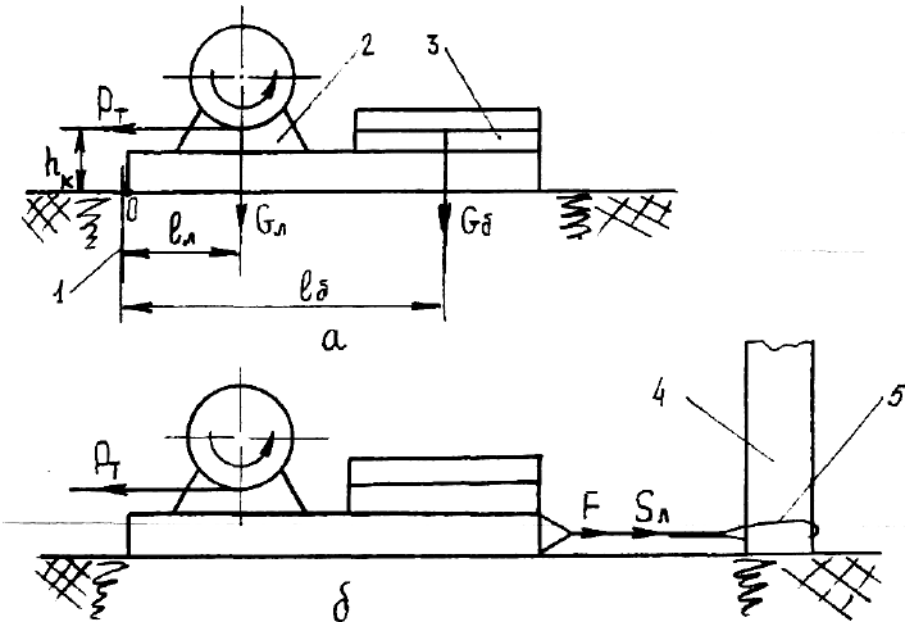

Fig. 3 – Schemes of securing the winch: 1 – emphasis; 2 – winch; 3 – ballast; 4 – column; 5 - strut.

rope receiving drum of the cargo winch - A - is determined by the expression

$$A \geq 20\,B, \quad m. \qquad (17)$$

The longitudinal axis of the drum should be perpendicular to the direction of the rope, which crosses the drum in the middle of its length (see Fig. 1).

14. Choose the method of fastening the winch and perform the necessary calculations. If the fastening corresponds to fig. 3, and, then the shift of the winch 2 is prevented by the stop 1, and the overturning is prevented by the ballast 3. The mass of the ballast - $M_Б$ - is found by the expression

$$M_Б = \kappa_C \frac{P_T h_K - G_Л \ell_Л}{g \ell_Б} \quad кг, \qquad (18)$$

where P_T is the traction force calculated according to (10);

h_K - the distance between the supporting surface of the winch frame and the axis of the load rope, m;

$G_Л$ - winch weight force, H;

$\ell_Л$ - shoulder on which the weight of the winch acts, m;

$\ell_Б$ - the shoulder on which the weight of the ballast acts, m;

g - acceleration of gravity, m/s2;

k_C - coefficient of stability (take $\kappa_C = 2$).

In the case when it is impossible to drive the abutment into the ground, the winch is tied to the nearest building according to the scheme of fig. 3, b. The effort acting on this structure from the side of the winch - $S_Л$ is calculated as follows:

$$S_Л = \kappa_C (P_T - F), \quad N \qquad (19)$$

where F is the force of friction between the winch frame and the surface of the mounting platform, N.

The force of friction is equal to

$$F = f(G_Л + G_Б) \quad N, \qquad (20)$$

where f is the coefficient of friction of the winch frame sliding on the support surface, the value of which depends on the frictional properties of the contacting surfaces (steel on steel f = 0.15; steel on dry soil or concrete f = 0.45; dry wood on concrete f = 0.50; steel on wood f = 0.60).

15. If it is necessary to pull the load from the front wall of the building or structure, the pulling force is determined as follows.

If the brace is directed horizontally, apply the formula

$$S_B = Q_{MAX}\, tg\, \alpha, \quad N \qquad (21)$$

where S_B is the pulling force, N;

Q_{MAX} – weight force of the load, N;

α is the angle by which the longitudinal axis of the hoist deviates from the vertical due to the pulling of the load, degrees.

- If the brace is directed upwards from the horizontal plane, then

$$S_B = Q_{MAX} \frac{\sin \alpha}{\sin(\alpha + \beta)}, \quad N \qquad (22)$$

where β is the angle between the vertical and the direction of the tension, degrees.

If the guy is deflected from the horizontal plane down and creates an angle β relative to the vertical, there is a danger of overloading the hoist.

The effort on the pulley P in a similar situation is equal

$$P = Q_{MAX} \frac{\sin \beta}{\sin(\alpha + \beta)}. \quad N \qquad (23)$$

16. Determine the effort of pulling the cargo from the cargo receiving platform into the premises - S_{BT} - under the condition

$$S_{BT} \geq F, \qquad (24)$$

where F is the force of friction (sliding - F_{KOB}, or rolling - $F_{KOЧ}$, depending on the conditions of retraction).

If retraction takes place by pulling on a wooden pallet or on a supporting steel sheet in the direction against the inclination of the supporting surface (at an angle α_B , degrees to the horizon), then the retraction condition has the form

$$S_{BT} \geq F_{KOB} + Q_{MAX} \sin \alpha_B \qquad (25)$$

and the retraction force is equal to

$$S_{BT} \geq Q_{MAX} (f \cos \alpha_B + \sin \alpha_B), \quad N \qquad (26)$$

where f is the coefficient of friction of the load sliding on the support surface (see the explanation of expression (20)).

If $\alpha B < \alpha_B < 15^0$, it is accepted

$$S_{BT} \geq Q_{MAX} (f + \sin \alpha_B), \quad N. \qquad (27)$$

The pull-in effort can be significantly reduced by using backing rollers.

If $\alpha_B < 15^0$, then the retraction force is equal to

$$S_{BT} \geq Q_{MAX} \left(\sin \alpha_B + \frac{f_K' + f_K''}{d_K} \cos \alpha_B\right), \quad N \qquad (28)$$

where f_K' and f_K'' are the coefficient of rolling friction between the support surface and the

rollers, as well as between the rollers and the retracted load;

d_K - roller diameter, m.

If $\alpha_B < 15^0$, then $cos\ \alpha_B \approx 1$. Then the retraction force is

$$S_{BT} \geq Q_{MAX}\ (sin\ \alpha_B + \frac{f_K' + f_K''}{d_K}),\ N \qquad (29)$$

In the case of retraction along the horizontal plane, that is, when $\alpha_B = 0$,

$$S_{BT} \geq Q_{MAX} \frac{f_K' + f_K''}{d_K},\ N \qquad (30)$$

It should be noted that the coefficient of rolling friction has the dimension of length and, in particular, is equal to

steel by steel - $0.05 \cdot 10^{-2}$ m;
steel on wood - $(0.04 \ldots 0.07) \cdot 10^{-2}$ m;
steel on concrete - $0.06 \cdot 10^{-2}$m;
wood by wood - $(0.05 \ldots 0.08) \cdot 10^{-2}$m;
steel on soil - $0.22 \cdot 10^{-2}$m.

Finally, according to the project, the nomenclature of technical means for pulling cargo into the premises, their locations and fastening methods are determined.

Conclusions

The need for the construction of rigging and assembly installations, which accommodate rigging and assembly mechanisms, rigging devices and equipment, often arises at the objects of reconstruction or technical rearmament of enterprises of the industry. For the most part, this work is based on the practical experience of foremen of assembly organizations or rigging foremen. The desire to avoid cases of destruction of structural elements under load leads to the establishment of excessive safety margins, which causes unreasonable consumption of materials in their manufacture and creates unnecessary difficulties in application.

The technology of construction of rigging and assembly installations proposed in the article involves the preliminary development of their schemes, during which, in an appropriate sequence, their normatively justified components are calculated or selected, which excludes the adoption of voluntary decisions when creating such responsible structures.

REFERENCES

1. Marshev V. Z. Installation of technological equipment. Builder's directory. - M.: Stroyizdat, 1983.
2. SNiP 3.05.05-84. Technological equipment and technological pipelines. - M.: 1985.
3. Vainberg A.A., Grosul L.I. Fundamentals of repair and installation of equipment for grain storage and processing enterprises. M.: Kolos, 1992.
4. Tarasov V.P. Technological equipment of grain processing enterprises. – Barnaul: Izd-vo Alt GTU, 2010.

УДК 621.876.113

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РОЗРОБКА СХЕМИ ТАКЕЛАЖНО-МОНТАЖНОЇ УСТАНОВКИ

Анотація

В умовах реконструкції або технічного переозброєння підприємств по зберіганню і переробці зерна бувають випадки відсутності або неможливості застосування на об'єктах монтажу необхідних універсальних підйомно-транспортних засобів, зокрема, будівельних баштових або самохідних стрілових кранів. У подібних ситуаціях вдаються до спорудження спеціалізованих такелажно-монтажних установок, які базуються на застосуванні такелажно-монтажних механізмів, такелажних пристроїв і такелажної оснастки. Наведена послідовність дій, визначень і розрахунків при цьому практично виключає прийняття необґрунтованих і помилкових рішень. Найчастіше такі установки розташовують біля фасадних стін будівель, облаштованих монтажними прорізами і вантажно-прийомними площадками, поліспастами і вантажними лебідками. Обирають конструкцію, місце розташування і засоби кріплення монтажної балки або стріли. Уточнюють і приймають вантажопідйомність лебідки, з числа тих, що є у розпрядженні. Визначають потрібну кратність поліспаста, його коефіцієнт корисної дії, величину тягового і розривного зусиль у вантажному канаті. Обирають тип і діаметр каната, а також його довжину. Визначають канатоємність барабана вантажної лебідки і уточнюють її технічні характеристики. Обирають місце розташування і метод закріплення лебідки. У разі необхідності, розраховують величину маси балластного контрвантажу. Обирають місце розташування і спосіб кріплення відвідного блока, визначають величину зусилля з боку цього блока на будівельну конструкцію або якір. Обирають тип якоря і у разі потреби розраховують його стійкість. У разі необхідності відтягування вантажу від фасадної стіни будівлі чи споруди, розраховують величину зусилля відтягування і обирають потрібну для цього лебідку або таль. Визначають зусилля втягування вантажу з приймальної площадки у приміщення і потрібні для цього технічні засоби.

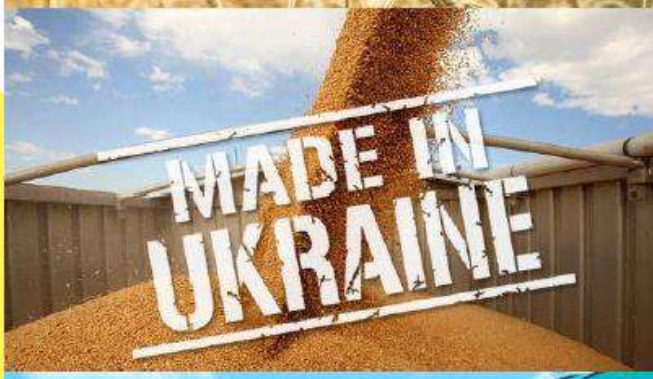
Ключові слова: монтаж; такелаж; стріла; поліспаст; вантажний канат; лебідка.

Received 19.02.2022 **Revised 20.03.2022**
Reviewed 05.03.2022 **Approved 04.10.2022**

Cite as Vancouver Citation Style
Soldatenko L., Shipko A., Shipko I. Development of the scheme of the rigging and assembly installation. Grain Products and Mixed Fodder's, 2022; 22 (3, 87): 46-50. DOI https://doi.org/10.15673/

Cite as State Standard of Ukraine 8302:2015
Development of the scheme of the rigging and assembly installation. / Soldatenko L. et al. // Grain Products and Mixed Fodder's. 2022. Vol. 22, Issue 3 (87). P. 46-50. DOI https://doi.org/10.15673/

ФАКУЛЬТЕТ
ТЕХНОЛОГІЇ ЗЕРНА І ЗЕРНОВОГО БІЗНЕСУ



ХАРЧОВІ ТЕХНОЛОГІЇ

Освітні програми:

- Технології та управління зерновим бізнесом;
- Технологія зберігання зерна та елеваторний бізнес;
- Технології та управління кормовим бізнесом;
- Технології та управління хлібопекарним і кондитерським бізнесом.

ПІДПРИЄМНИЦТВО, ТОРГІВЛЯ ТА БІРЖОВА ДІЯЛЬНІСТЬ

Освітня програма:

- Міжнародна торгівля зерном;

ГАЛУЗЕВЕ МАШИНОБУДУВАННЯ

Освітня програма:

- ІТ конструювання та обслуговування обладнання (Зернопереробної галузі).

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- Керівниками агропромислових підприємств;
- Керівниками машинобудівних заводів, комерційних структур технічного сервісу;
- Керівниками торгівельних, зерноторгівельних компаній та їх підрозділів;
- Керівниками підприємств малого бізнесу;
- Керівниками біржових структур та їх підрозділів;
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- Технологами, головними інженерами, завідуючими лабораторіями, менеджерами з якості;
- Брокерами на товарних біржах;
- Фахівцями з логістики;
- Експертами з зовнішньоекономічних питань;
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