Таким чином, доведена перспективність введення в технологію етанолу стадії ІЧ-обробки зерна і в подальшому переводу процесу на спосіб «холодного» затирання, яке вже застосовують у виробництві спирту в Німеччині і в Росії.

Висновки:

1. Виявлено кореляційну залежність біохімічних, мікробіологічних і реологічних характеристик зерна від його виду, вологості і температури мікронізації. Ці дані дозволяють оцінити глибину змін вихідної сировини і обумовити вибір режимів ІЧ-нагріву.

2. Встановлено, що ІЧ-обробка сировини дозволяє отримувати сусло за низькотемпературним одноступеневим способом «холодного» затирання. Ці технологічні прийоми сспрощують апаратурну схему виробництва, знижують енергозатрати, підвищують вихід етанолу.

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INVESTIGATION OF WORKING ENVIRONMENT PARAMETERS AND RISK ASSESSMENT IN DAIRY PROCESSING

The main working environment parameters such as noise, microclimate and lighting were investigated in this research for two Bulgarian medium small and medium dairy processing enterprises. The measured daily noise exposure levels were in the 69.7 ÷ 90.1dB (A) range. The average illumination of the working surfaces was between 104 and 353 lx. The air temperature varied from 20.9 to 27.3^{0}C, the relative humidity from 39.3 to 93.3 %, and the air velocity from 0.02 to 0.17 m/s. Occupational risk assessment for the workers' health was carried out using a simple/flexible five-step method. Workplaces with unjustified and inadmissible risk were determined for which compulsory health protective measures would have to be applied.

Ключевые слова: охраны труда, условия труда, параметры, риска, оценка, производство молочных продуктов.

Приведены результаты определения значений основных параметров рабочей среды: шума, микроклимата и освещения в двух молокоперерабатывающих предприятиях (малого и среднего) класса. Ежедневный уровень воздействия шума составлял (69,7…90,1) dB(A). Среднее освещение рабочей поверхности – (104,0…353,0) lx. Температура воздуха – (20,9…27,3) °C, относительная влажность – (39,3…93,3) %, скорость воздуха – (0,02…0,17) m/s. Определена оценка риска для работников с помощью простых/гибких пятиступенчатых методов. Выявлены рабочие места с неоправданным и недопустимым риском, для которых крайне важно, чтобы были внедрены принятые меры по защите здоровья работников.

Key words: occupational safety, working environment, parameters, risk, assessment, dairying.

Introduction. Occupational health and safety are among Bulgaria's priorities according to the obligations assumed by the country as an EU Member State. The provision of healthy and safe working conditions underlies the success and future development of the food industry, dairy processing enterprises in particular. Efficient organization aimed at ensuring health and safety at work requires not only good knowledge of current legislation but also awareness of the importance of this activity for the overall labor regulation. Working conditions which have an adverse effect on human health may cause long-term health problems and eventually, occupational diseases. Therefore, effective control of working environment factors is crucial for increasing the competitive power and productivity of enterprises. Also, it contributes to the sustainable development of society. The main working environment factors controlled are industrial noise, microclimate and lighting [1, 3, 4, 8].

According to current regulations, it is not allowed to exceed the established norms for industrial microclimate, noise, vibration, dust, toxic substances, lighting, and non-ionized and laser radiation in working areas and workplaces. It is the employers' obligation to carry out risk assessment for all workplaces. Risk assessment is a key factor in the management of safe working environments and the basis for the making of

decisions and implementation of measures for the purpose of protecting workers' health. It is also a basic stage of risk management (BDS ISO 31000). Its accuracy determines the effectiveness of the methods and means of protection. Different risk assessment methods are applied in practice (BDS ISO 31010). There is no universally established method – any employer can choose a suitable one. Various kinds of risk assessment software are also available on the market [2, 5, 6, 8].

In our previous study, we found that typical health hazards and risks for workers in the dairy industry are related to physical injuries inflicted by conveyor belts, automatic lines for container filling and closing, falling loads, equipment, cut glass, moving transport, slipping or falls from heights, electric shock, thermal effects of high surface temperature (pasteurizers, dryers, pipes, etc.), adverse overheating or overcooling microclimate which causes predisposition to colds, mucosal inflammation, swelling and pain in the ankle joints, loud noise from the operation of technological equipment (centrifuges, blenders, dryers, packing machines, etc.), use of artificial lighting producing low and insufficient illumination which leads to visual fatigue, conjunctivitis, nervous fatigue, headaches, insomnia, etc.; impact of hazardous chemicals in the process of cleaning and disinfection; manual handling of loads; unfavorable postures, monotonous and repetitive actions, etc. [4].

The aims of this research were to investigate the main working environment parameters in Bulgarian medium small and medium dairy processing enterprises and perform occupational risk assessment for the workers' health using a five-step method.

Materials and Methods. The objects of this research were two Bulgarian medium small and medium dairy processing enterprises. Three main working environment parameters were investigated: industrial noise, microclimate and lighting.

Noise measurement was carried out according to standards BDS EN ISO 9612:2009 and BDS ISO 1999:2004. To this end, a type HD 9102 portable sound-level meter produced in Italy and equipped with a sound calibrator was used. It had the following technical parameters: measuring range: (30…130) dB; resolution: 0,1 dB; accuracy class: 2; measuring temperature: (minus 5…50) °C. Daily noise exposure levels ($L_{EX,8h}$) and uncertainties (U) were calculated.

The artificial lighting was investigated according to the Bulgarian legislation (Regulation No.49/1976) and the BDS EN 12464-1:2011 standard. The measurement was carried out using an SM700 Milwaukee portable lux meter produced in Italy, with the following technical parameters: measuring range: (0…50 000) lx; resolution: ±1 lx, ±10 lx, ±100 lx; and measuring temperature: (0…50) °C.

The microclimate parameters temperature (t °C), relative humidity (φ, %) and air velocity (v, m/s) at workplaces were investigated according to the BDS 14776-87 Bulgarian standard. All measurements were carried out during the hot period of the year. Data were obtained using an HVACR Datalogger 2003 portable thermo-hygro-areometer with measuring probes HP472AC and AP471S1, produced in Italy. The measuring ranges were (0…40) m/s; (5…98) %RH; (minus 20…80) °C. The accuracy was ±0,05 m/s; ±2 % RH; ±0,3 °C.

The simple/flexible five-step risk assessment method (Fig. 1) developed by Reinhold was used in this research [7]. The method uses *correspond to the norm/does not correspond to the norm* principle. The motivation to use this method was found in the BS 8800:2004 standard which recommends five risk levels and is easy to understand by employers and occupational safety specialists. Numerical criteria for each risk level were derived from the current legislation and standards.

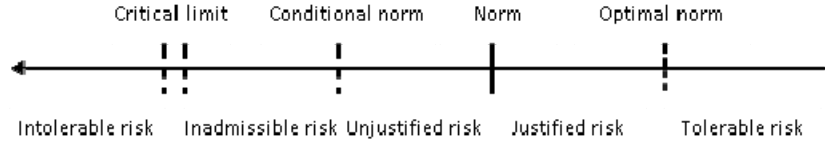

Fig. 1. Five-step risk assessment method by Reinhold [7]

Results and Discussion. The results of the investigation of the working environment parameters in two Bulgarian dairy processing enterprises are presented in Table 1. In one of the enterprises studied, measurements were also made in the wastewater treatment plant. Unlike classical production technology, the data obtained concerned enterprises which used modified technologies (application of membrane technology, multi-level heating, multi-stripping, etc.) that improved working conditions.

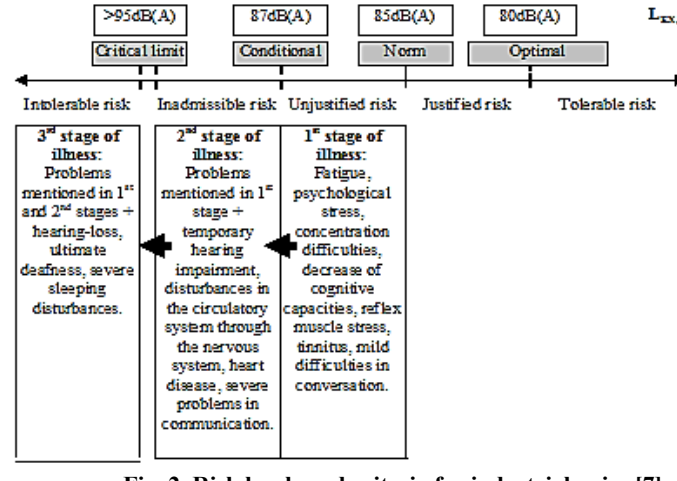

Fig. 2. Risk levels and criteria for industrial noise [7]

Figure 2 shows the risk levels and noise criteria at the workplaces. Similarly, a risk assessment of the microclimate and lighting of the workplaces in the investigated dairy processing enterprises was carried out.

Table 1

Working environment parameters in Bulgarian dairy processing enterprises

Working area/workplace	Daily noise exposure level		Average Illumination,	Microclimate		
	$L_{EX,8h}$, dB	U	lx	t, °C	φ, %	v, m/s
Enterprise 1						
Milk reception department	88,1	3,0	**	***	***	***
Laboratory	*	*	353,0±23,0	25,0±0,1	50,1±0,2	0,02±0,01
Yellow cheese production hall	75,9	1,1	151,0±37,0	23,3±0,1	43,5±0,1	0,14±0,01
White cheese production hall						
• Heat exchanger department	82,4	3,3	130,0±28,0	27,2±0,1	58,4±1,0	0,17±0,01
• Production department during operation	69,7	2,3	104,0±20,0	25,0±0,1	69,0±4,3	0,02±0,01
• Production department after cheese pan steaming	*	*	104,0±20,0	27,3±0,7	93,3±0,8	0,02±0,01
• Pre-maturation and sealing section	76,0	2,0	229,0±18,0	25,6±0,1	50,1±0,2	0,09±0,01
Butter production hall						
• Production department –centrifugal separation section	90,1	3,1	213,0±47,0	22,4±0,4	39,3±0,9	0,07±0,02
• Cutting and weighing section	*	*	151,0±5,0	22,4±0,4	39,3±0,9	0,07±0,02
Curd production hall	*	*	109,0±26,0	25,0±0,1	69,0±4,3	0,02±0,01
Packaging department	*	*	229,0±18,0	25,5±0,1	50,1±0,2	0,09±0,01
Reverse osmosis department	79,8	3,3	230,0±17,0	22,4±0,4	39,3±0,9	0,02±0,01
Enterprise 2						
Yellow cheese production hall						
• Heat exchanger department	87,9	3,1	123,0±16,0	23,1±0,1	67,1±0,3	0,17±0,05
• Production department –rennet coagulation section	72,0	1,3	145,0±17,0	23,5±0,4	73,0±0,2	0,04±0,02
• Production department – thermoplastification section	73,3	1,8	**	20,9±0,0	93,0±0,6	0,04±0,02
Curd production hall	71,6	1,2	119,0±19,0	23,7±0,1	74,9±2,1	0,08±0,01
Packaging department	72,8	2,6	152,0±11,0	23,0±0,6	77,2±1,3	0,03±0,01
Wastewater treatment plant						
• Mechanical treatment department	78,0	2,6	**	21,8±0,5	68,1±1,4	0,05±0,01
• Wastewater heating department	75,5	3,1	**	21,8±0,5	68,1±1,4	0,05±0,01

*Low noise level; **Combined natural and artificial lighting; ***Outdoor workplace

The data referring to the daily noise exposure level (table 1) showed that at some workplaces (the centrifugal separation section and the milk reception department in enterprise 1, and the heat exchanger department in enterprise 2) workers were exposed to noise levels above the established conditional norm of 87 dB (A), which corresponded to the limit exposure level. Workers at these workplaces were exposed to inadmissible risk (fig. 2). Therefore, it is imperative for them to use personal protective equipment. For all other workplaces in the investigated enterprises, the daily noise exposure level was below the optimal norm of 80 dB (A), which corresponded to the lower limit for action. Workers at these places are at tolerable risk, so there is no need to take action to protect them against noise. The heat exchanger department in the white cheese production hall of enterprise 1 was an exception, but the daily noise exposure level for work at this place was below the limit of 85 dB (A), corresponding to the upper limit for action. Hence, the risk was justified (fig. 2). However, the use of personal protective equipment was also recommended for workers at this workplace.

Our study showed that overall uniform lighting was provided to production halls. At some workplaces there was combined natural and artificial lighting. The results obtained (table 1) showed that the measured average illumination of the working surfaces met the standard (100±500) lx)according to the current legislation in Bulgaria. In conformity with the accepted BDS EN 12 464-1:2011 standard which sets out lighting limits from 300 lx to 500 lx, the risk assessment carried out showed that workers at all workplaces were exposed to unjustified risk, which could lead to fatigue, irritation, headache and stress. In view of the measurement results, increased lighting in the production facilities can be recommended in order to ensure better visual comfort. It should be noted, however, that this standard is not binding and does not specify lighting requirements relating to the safety and health of workers at work.

With regard to the microclimate, the measured values of the parameters were within the optimal norms for temperature (20…25) °C, relative humidity (40…60) % and air velocity (0,3…0,5) m/s. At the heat exchanger department workplace (enterprise 1), where

there was a significant thermal load, the air temperature was higher than at the other workplaces but it did not exceed the maximum permissible rate of 28 °C during the warm period. It should be noted that the dairy processing facilities met the technological requirement for maintaining temperatures above 20 °C. At some workplaces, the humidity measured was higher than the optimal humidity, but the values of this parameter did not exceed the limit values (30…75) % during the warm period. It reached around 93 % in the white cheese production department after cheese pan steaming and in the thermoplastification section of the yellow cheese production department. However, these processes in cheese manufacture are very short and the work organization in the enterprises studied requires workers to take a break after these operations. The risk assessment showed that in terms of microclimate in the enterprises studied, workers were at tolerable risk, whereas in the pasteurization unit they were at justified risk. Therefore, no additional health protection measures were required.

Conclusions

The main working environment parameters such as noise, microclimate and lighting were investigated for two Bulgarian medium small and medium dairy processing enterprises. The results obtained showed that in the enterprises studied, healthy and safe work environment was ensured which met the established norms in Bulgaria. Workplaces with unjustified and inadmissible risk were determined for which compulsory health protective measures would have to be applied. Results obtained for the production halls of medium enterprises can be used for such small enterprises. A simple and flexible method was presented for assessing the risk for workers in the food industry, dairy processing in particular, which can be applied by small and medium enterprises. This method can be used as an alternative to help firms carry out risk assessment at work in conformity with employers' legal obligation under Bulgarian legislation, as well as enhance business management efficiency.

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ИССЛЕДОВАНИЕ МИГРАЦИИ ТЯЖЕЛЫХ МЕТАЛЛОВ ПРИ ЭКСТРАКЦИИ РАСТИТЕЛЬНОГО СЫРЬЯ

Рассмотрены актуальные вопросы экологической чистоты растительного сырья, а также влияние тяжелых металлов на организм человека. Исследовано содержание тяжелых металлов в ягодах, корнях и корневищах некоторых растений. Полученные экспериментальные данные сопоставлены с нормативной документацией. Проанализирован переход токсичных элементов во время экстракции при оптимальных условиях экстрагирования.

Ключевые слова: тяжелые металлы, токсичность, экстракция, растительное сырье.

The pressing questions of ecological cleanness of digister, and also influence of heavy metals, are considered on the organism of man. Maintenance of heavy metals is investigational in berries, roots and rhizomes of some plants. The experimental findings are confronted with a normative document. The transition of toxic elements is analysed during extraction at the optimum terms of extracting.

Keywords: heavy metals, toxicness, extraction, digister.

Производство растительных экстрактов – приоритетное направление переработки пищевого растительного сырья для его использования в технологии пищевых продуктов общего и специального назначения [1]. Поскольку растения относят к одним из наиболее доступных источников биологически активных веществ, которые способны оказывать на организм человека защитное и оздоровительное действие. Включение в рецептуру продуктов растительного сырья с определенными лечебно-профилактическими свойствами позволяет снижать и даже полностью избегать внесения синтетических пищевых добавок – красителей, ароматизаторов, консервантов. Это особенно важно при разработке продуктов специального назначения, в том