Yoghurt enrichment with natural bee farming products

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Abstract

Introduction. Bee pollen is a unique and unparalleled natural bioactive substances source. Using it in conjunction with the popular functional fermented milk product - yogurt will expand its product range and increase the biological value.

Materials and Methods. Dried bee pollen's moisture determination was made by gravimetry methods, based on the sample weight loss due to desiccation, until constant weight was reached. Test and control yogurt samples were studied by applying standard techniques for milk and milk products set forth in the regulations of Ukraine.

Results and discussion. It is found that bee pollen pellet drying to a moisture content of 2 - 4%, increases the flow rate of powder almost by 90%. The sample having moisture content of 2% will have a bulk density exceeding 12.5% compared to the sample having moisture content of 10%. Raw output will also increase by 3.7%. By contrast, apparent density and weight fraction of losses decreases, which has a positive impact on pollen efficiency of use and distribution in bulk yogurt. Moreover, the weight fraction of losses decreases by fourfold (4.6% vs. 1%).

It was experimentally determined that pollen can deteriorate microbiological characteristics of yogurt.

It was proved that treatment of crushed bee pollen pellet sample with ultraviolet allows improving yogurt microbiological safety indicators. Namely, to reduce the presence of coli-forms to 0, mould – to 10 CFU/cm³.

Conclusions. The proposed bee pollen pellet treatment method will improve the technological and microbiological characteristics of pollen powder. This provides for yoghurt production biotechnology using bee farming products.

Introduction

Malnutrition reduces age of human life by 2-3 times. Up to 90% of diseases are directly related to malnutrition. [1].

Nutrition basis incorporate the food intake balance principle, thus ensuring optimal body's need for food and bioactive capable of exhibiting their maximum efficiency in the body.

Certain food products or components have healthful and prevention benefits. These products are known as “functional food products”. For the first time they have been exported to the European market from Japan in 1996 [2, 3, 4].

These food products can include fruits and vegetables, whole grains, dietary fibers and other substances including functional components: carotenoids, flavonoids, minerals, vitamins and similar substances [5].

Functional characteristics of many traditional fermented milk drinks are discovered and studied. Currently there are new food products enriched with useful components under development.

Among all functional food products yogurt is considered to be ideal medium for nutritional ingredients delivery. [6] Especially, such as components of some bee farming products (honey, royal jelly, bee pollen pellet).

Bee pollen pellet has a form of dense balls. Each such ball is covered with agglutinating water - and fat-soluble substances. The first ones consist of nectar mono- and disaccharides, other contain propolis components. Since agglutination substances do not dry quickly, the fresh pollen pellet moister content is 25-30%. Therefore, after collection it must be dried to a residual moisture content not exceeding 10%, which ensures its storage for 240 days at room temperature, and 360 - at 12 ° C below 0 [7, 8, 9].

Bee pollen contains proteins, amino acids, carbohydrates, minerals, fats. It also includes hydrocarbons, organic acids, vitamins, sterols, flavoring, flavonoids, higher alcohols, phosphatides, phenolic and other biologically active substances. Due to such composition the pollen can exhibit activity of various types: antioxidant, antibacterial, hepatoprotective, antihypoxanth, etc. [7,10, 11].

Such a wide enough action range ensured pollen pellet application in apitherapy, alternative and traditional medicine [7,12]. Its application in the food industry is quite insufficient. There are several patents of Ukraine for art of manufacture of butter using powdered pollen (UA 96219 1. Method for Making Butter with Filltr; UA 94284 Method for Making Butter with Filltr; UA 94478 Method for Making Butter with Filltr), sweet creamed curds using bee farming products, including pollen (UA 47718 Cottage-Cheese Dessert) and fish rolls using fillings of plant origin (UA 67388 Рулет рибний функціонального призначення "Дімаре"; UA 67390 Fish Rolls Functional Setting "Marino", UA 67389 Fish Rolls Functional Setting "Royal", UA 67391 Fish Rolls Functional Setting "Atlantis").

Products listed above are wholesome and important, but they have no probiotic effect on human body, like yogurt. Besides, the above specified sources have no sufficient information on pollen preparation technology for use. Therefore, the use of bee pollen pellet to enrich and improve yoghurt remains an open question.

Materials and methods

The following was used for experimental process: bee pollen pellet; milk with a fat content of 3.2%; DVS-starter cultures Streptococcus thermophilus, Lactobacterium delbrueckii subspecies bulgaricum, Lactobacterium acidophilum made by Bulgarian manufacturer Genesis Laboratories. All raw materials meet the regulatory requirements for this type of product.

Bee pollen pellet samples were prepared by drying in a convection oven at a temperature of 32 ± 2°C to a moisture content of 10, 8, 6, 4 and 2%. To determine water weight fraction in bee pollen pellet samples the drying method was used, as well as methods proposed by Portuguese scientists Maria G.R. Campos, Stefan Bogdanov, Ligia Bicudo de Almeida-Muradian, Teresa Szczesna, Yanina Mancebo, Christian Frigerio, Francisco Ferreira [13].

Pollen grinding was performed using laboratory mill-pounder "Pulverisette – 2" to a particle size of 10-15 microns. In all cases, samples were ground to better homogenization of the batches and a rate of each of the samples (approximately 2 g, except method IV which used approximately 1 g) was submitted to the process. All batches were analyzed in triplicate, except for the Karl Fischer's, which was made in two duplicates.

Dried bee pollen's moisture determination was made by gravimetry methods, based on the sample weight loss due to desiccation, until constant weight was reached. Moisture content of samples submitted was calculated using the Equation 1:

$$\%moist = 100 - \left[\frac{m' - t}{m - t} \cdot 100\right] \quad (1)$$

where:

m = total mass of the system (glass + sample) at the beginning of the process;

m' = total mass of the system (glass + sample) at the end of the process;

t = mass of glass used.

Quartz treatment of pollen pellet thin layer performed using non-ozone bactericidal lamp made by German manufacturer Osram -ОББ-15ПП model "15W T8/G13".

Flow rate, bulk density and other technological parameters of pollen powder were determined by weighing. Microbiological studies were carried out according to standard study procedures set forth in standard process documentation of Ukraine.

Bactericidal treatment was carried out in a dry room, the humidity of which didn't exceed 5-10%. Dryness of air was observed to prevent sticking and clumping of fine pollen powder particles and improve its mixing with milk base.

Yogurt control and test samples were produced under similar laboratory conditions of the same raw materials and characterized by availability of bee pollen pellet content treated using different methods (UV-treated and untreated). Its content in test yoghurts was 0.15%.

There were three sample made. First sample (K) - control sample without fillers. Second (O1) – test sample containing milled to a particle size of 10 micron pellet UV-untreated. Third (O2) – test sample with pollen pellet powder that was subjected to antimicrobial treatment.

All fermented milk drinks samples were acidified to reach the acidity level of 90°T at 39 ± 2°C. Then samples were cooled to a temperature of 10 ± 2°C. Yogurt was stored in sealed packaging (glass containers of 150 cm³ with screw-tight plastic lids) at 4 ± 2°C.

The final value of each indicator was equal to the average value following the results of this indicator triple measurement.

Yogurt samples were analyzed on a third day of storage.

Mathematical data processing performed using standard set of computer programs integrated in Microsoft Office Excel 2010.

Results and discussion

Pollen grinding can cause problems since insufficiently dried product leads to the blockage and failure of the system. Significant powders loss as a consequence of substances sticking on mill parts. Therefore, study was undertaken regarding the effect of pollen pellet moisture content on grinding efficiency.

The data obtained during the determination of raw materials yield and loss are shown in Table 1.

Table 1

Bee pollen loss at the stage of grinding

Characteristics	Moisture, %				
	10	**8**	**6**	**4**	**2**
Amount of pollen, g	150	150	150	150	150
Yield rate, g	143,1	145,35	147,15	148,35	148,5
Pollen loss, %	4,6	3,1	1,9	1,1	1

After grinding of five pollen samples weighing 150 g dried to the different (10, 8, 6, 4 and 2%) moisture content, we found that the water content in raw material directly affects its yield and share of losses. Sample with 10% of moisture content had the lowest yield rate - 143.1, the highest yield rate was obtained from samples having 4 and 2% of moisture content - 148.35 and 148.5 g, respectively, with the difference between them of only 0.15 g. The difference in this value between sample having 10 and 4% of moisture content was 5.25 g, which was ≈ 8%. This is significant. Since, according to the formulations in TU U15.5-00493706-002: 2009, 5.25 g of pollen can be used to produce 350 - 1750 g of finished yogurt.

The experiment found that the rate of raw material loss characterized with direct proportion to the moisture content of bee pollen samples. Namely, raw material loss decreased with the moisture content decrease. The lowest loss rate was observed in pollen having moisture content of 4 and 2%. The difference between these samples was 0.1%. Losses of sample containing 10% of moisture were 4.6%, which is 3.6% higher than the sample having moisture content of 2 % and 3.5 – compared to sample having 4% of moisture content.

In practice, unmilled pollen drying can be used until it reaches moisture content of 4%. It will be rational in terms of cost efficiency in the raw material preparation process for using it in biotechnology of yoghurt with natural bee farming products.

By studying the technological characteristics of the bee pollen pellet powder we can assess its quality and predict the mixing process with a milk base. As it is known, that the more uniform is powder, the more uniformly it will be distributed in a liquid medium [14].

Dependency study was performed regarding technical parameters of the bee pollen pellet powder and its moisture content. Results for the bulk weight, bulk density are shown in Table 2, and flow rate – in Figure 1.

Table 2

Technological characteristics of bee pollen pellet powder

Characteristics	Moisture, %				
	10	8	6	4	2
Apparent density, g/cm^3	0,56	0,58	0,6	0,62	0,63
Bulk density, g/cm^3	0,78	0,77	0,77	0,76	0,76

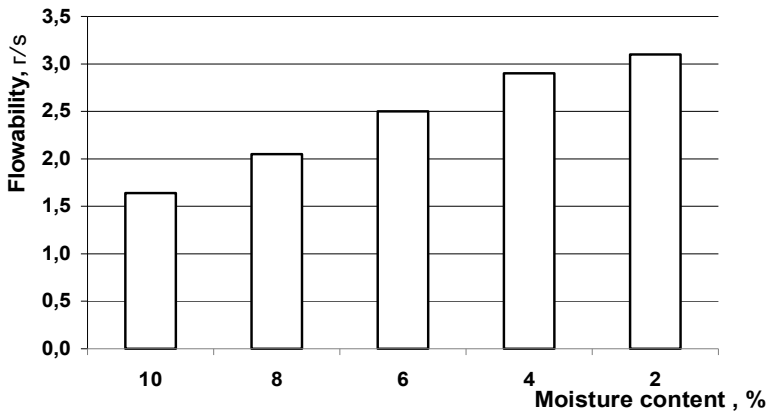

Figure 1. Pollen pellet powder flow rate and moisture content dependency

Powder technological data change depending on its moisture content is directly proportional to the flow rate and bulk density and inversely proportional to the apparent density. Results for samples having moisture content of 4 and 2% had insignificant differences. Therefore, for costs reason, same as in the previous case, it may be advisable to dry the pollen pellet to the moisture content of four percent.

Based on previous studies, as well as studies of foreign scientists, pollen can become a source or growth factor for adverse yogurt microbial population [15].

The values obtained as a result of microbiological study of control and test (O1) yogurt samples are summarized in Table 3.

Table 3

Bacteriological index for yoghurt with bee pollen pellet

Name of indicator	Sample	
	К	О1
Coli-forms in 0,1 g	not detected	in 1g
Pathogens, including Salmonela, in 25 cm^3	not detected	not detected
Staphylococcus aureus, в 1,0 cm^3	not detected	not detected
* Yeast, CFU/cm^3, no more than	50	50
in sample	not detected	not detected
*Mould fungi, CFU/cm^3, no more than	50	50
in sample	11	72

* – according to the current regulations of Ukraine.

Yogurt control sample is fully consistent with regulatory requirements to such product. O1 sample did not meet the standards in terms of two indicators. In 1g of O1 sample O1 there were coli-forms detected, which is not allowed. Mould fungi CFU exceeded the permissible level by 22 CFU/g.

In connection with the foregoing, it was decided to treat the powder derived from pollen with the ultraviolet lamps and analyze results obtained. Study was carried out only based on those indicators, the results of which were unsatisfactory (availability of coli-forms and moulds). The results obtained are shown in column chart with grouping in Fig. 2.

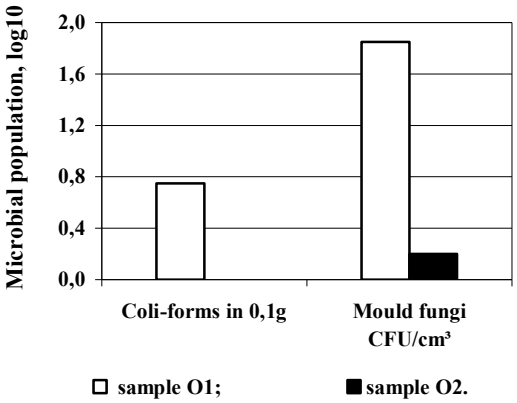

Fig.2. Microbiological indicators of test yogurt samples with bee pollen pellet

Pollen treatment using quartz lamp (O2) assisted in reducing the mould content to a level below the reference and maximum permissible. Number of coli-form bacteria in O2 sample decreased to zero. Other microbial safety indicators remained unchanged.

Thus, reducing the bee pollen pellet moisture content prior grinding to 4-2% will facilitate the grinding process and obtain powder with satisfactory technological parameters.

Pollen pellet powder ultraviolet treatment prior it's adding to the prepared milk base prevents adverse microbial population indicators growth in the finished fermented milk drink.

Conclusions

Bee pollen pellet drying to the moisture content of 4-2% enables preventing its substance sticking to the operating items of grinding devices and obtaining powder with satisfactory technological parameters.

Pollen powder treatment with bactericidal lamps prior adding the milk base will reduce the risk of adverse microbial population ingress.

Described methods allow using bee pollen pellet for fermented milk drinks production technology.

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