CHAPTER 14

DEVELOPMENT OF TECHNOLOGY FOR CURD DESSERTS WITH HONEY AND SAFFRON FOR ATHLETES DURING THE RECOVERY PHASE

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INTRODUCTION

Adequate and balanced nutrition is of paramount importance for the recovery and rehabilitation of athletes. Nutrition during the recovery period is similar to a standard sports diet but takes into account specific risks, including the prevention of sarcopenia (loss of muscle mass) and nutrient deficiencies. In combination with training, such nutrition is aimed at maintaining long-term nutritional status and increasing the body's endurance and resilience[1, 2].

Dairy products occupy a strategic place in the system of sports nutrition. After intense physical exertion, the body needs to solve three main tasks: regeneration of muscle fibers, replenishment of energy depots, and restoration of water-salt balance[3].

Milk contains two types of protein that perfectly complement each other for recovery. Whey protein is quickly digested, providing an instant influx of amino acids to the muscles ("anabolic window"). Casein is digested slowly, providing a stable supply of amino acids for several hours, which prevents

[1] Martínez-Sanz J. M., Menal-Puey S., Sospedra I., Russolillo G., Norte A., Marques-Lopes I. Development of a Sport Food Exchange List for Dietetic Practice in Sport Nutrition. *Nutrients*. 2020. Aug 11. Vol. 12 (8). 2403. DOI: 10.3390/nu12082403.

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night catabolism (muscle breakdown). Dairy products are rich in leucine, which is the main "trigger" for muscle protein synthesis[4, 5].

Dairy products are a source of lactose. The combination of milk protein with carbohydrates stimulates higher insulin levels than the consumption of carbohydrates alone. Insulin helps "transport" glucose and amino acids directly into muscle cells to quickly restore energy stores (glycogen)[6].

During training, an athlete loses minerals through sweat. Dairy products are natural sources of electrolytes. Calcium and magnesium are necessary for normalizing muscle contraction and preventing cramps. Potassium and sodium play a key role in maintaining water-salt balance, which prevents dehydration. Phosphorus is involved in the synthesis of ATP[7].

Athletes subject the skeleton to significant mechanical loads. The high bioavailability of calcium and vitamin D in dairy products helps increase bone density and reduce the risk of stress fractures[8].

The creation of nutritionally balanced products is a priority vector for the development of the dairy industry, since dairy raw materials are the fundamental basis of the daily diet of most categories of consumers. The strategic goal of developing innovative health-oriented desserts is to purposefully model their composition: optimizing the ratio of protein fractions (in particular, casein and albumin), correcting the lipid profile, and carbohydrate index[9].

Special attention is paid to the fortification of products with natural biologically active components (bee products, exotic spices), which not only increases the biological value and bioavailability of nutrients, but also forms unique organoleptic characteristics. Such a comprehensive approach allows you to differentiate the assortment, satisfying the specific needs of different

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population groups – from professional athletes to people who need dietary correction[10].

The purpose of the research is the scientific justification and development of the technology of a functional milk dessert based on Ricotta cheese and curd, enriched with bee products and saffron, intended for the restoration of the body after physical exertion.

The work was carried out in the laboratory of the Department of Milk and Dairy Products Technology of the Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv (Lviv, Ukraine).

1. Preparation of a curd base for dessert

Given the rapid spread of the trend for a healthy lifestyle and conscious consumption in Ukraine, there is an urgent need for applied scientific research focused on the development of innovative functional products for the nutrition of athletes during the recovery phase. Special attention should be paid to the creation of curd desserts enriched with plant raw materials as an effective means of increasing the nutritional value of the diet.

Curd is a complex source of nutrients, including proteins, bioactive peptides, amino acids, as well as a balanced composition of fats and a vitamin-mineral complex. Due to the high content of essential amino acids, this product plays an important role in supporting recovery processes and ensuring the harmonious development of the body.

Like curd, Ricotta is an unpressed cheese with a high moisture content. Its composition varies depending on whether it is made exclusively from whey or from a mixture of whey and milk. When Ricotta is made from a mixture of 95% sweet whey and 5% milk, it contains 68–73% moisture, 16% protein, 4–10% fat, and 4% lactose. Ricotta has a bland but pleasant taste. Its texture is soft and creamy.

The combination of curd (which provides structure and a light sourness) and Ricotta cheese (which adds delicate creaminess) will create the perfect balance for a dessert.

The results of the study of the physicochemical parameters of curd and Ricotta cheese as raw materials for the production of curd dessert are given in Table 1.

Three experimental samples were made:

Sample 1 – ratio of curd with 9% fat content:Ricotta – 1:1

Sample 2 – ratio of curd with 9% fat content:Ricotta – 2:1

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Table 1

Physicochemical parameters of curd and Ricotta cheese

Raw material	Mass fraction of fat, %	Mass fraction of moisture, %	Acidity, °T	pH
Curd	9	73	180	4.6
Ricotta cheese	10	74	28	6.1

Sample 3 – ratio of curd with 9% fat content:Ricotta – 1:2

When evaluating sample 1, it should be noted that the dessert was creamy and tender, but at the same time had sufficient structure and a light curd sourness. Ricotta cheese perfectly smoothed out the sour taste of curd.

Sample 2 had a more pronounced taste of curd and a better consistency. Ricotta cheese here acts as a natural softener and emulsifier.

The characteristics of sample 3 were as follows: the curd base was very airy, tender, almost mousse-like, with a minimal sour taste.

Therefore, sample 3 was chosen for further research and the creation of a premium, tender dessert with a creamy texture. Since whey protein (albumin) prevails over casein in this mixture, the resulting product will resemble a thick creamy mousse in consistency.

2. Justification and technological aspects of introducing saffron into curd desserts

Creating a new taste is a multi-stage and creative process that requires a combination of art, science, and marketing flair.

Saffron is a valuable raw material used in the food industry as a natural dye and flavoring. Its specific organoleptic profile and ability to give products an intense golden-yellow color are due to the high content of crocin, a carotenoid pigment with pronounced coloring ability. The use of saffron in dessert recipes, in particular fermented milk ones, requires precise dosing to achieve a balance of flavor shades. Variation in the percentage of saffron is limited to a very narrow range due to its high intensity.

To determine the optimal dose of saffron for adding to the curd base, curd base preparations were carried out with 0.2, 0.4, and 0.6 g of saffron per 1 kg of curd mass. To get the maximum color and aroma from the minimum amount, saffron must be activated. Saffron activation was carried out in two ways.

Method 1 (Infusion): saffron threads were crushed in a mortar, poured with a small amount of cream (20–30 ml) at a temperature of 45 °C, and infused for 15–30 minutes until a rich color and aroma were obtained.

Method 2 (With butter): saffron was slightly warmed in a small amount of melted butter.

It should be noted that for saffron extraction for a curd base, it is better to use the first method, since the mixture has a high humidity (76–78%), the cream will naturally enter the structure of the dessert, without creating the risk of stratification (the cream emulsion is easier to combine with wet Ricotta). Saffron infusion evenly colors the entire mass without the risk of greasy spots or lumps.

The feasibility of using the selected method is also due to the specifics of developing a product for sports nutrition. The use of low-fat cream (10–15%) compared to butter allows optimizing the lipid composition of the dessert, reducing its energy density. This prevents excessive load on the digestive system and ensures a high rate of nutrient absorption, which is essential for the diet of athletes.

Table 2 shows the organoleptic characteristics of the curd base with different doses of saffron (from 0.2 to 0.6%).

Table 2

Organoleptic characteristics of curd mass with saffron

Application rate, g/kg	Characteristics of the curd base
0.2	The curd base acquires a barely noticeable, pleasant yellow hue. The saffron flavor is very delicate, acting as an aromatic note against the background of the curd
0.4	Rich golden yellow color. The taste and aroma of saffron are well felt, but do not interrupt the main components. This is a balance between color, aroma and taste
0.6	The dessert acquires a bright orange (almost red) color. The appearance of pronounced bitterness, which makes the product unpleasant to the taste

The preservative effect of saffron is due to the presence of a complex of biologically active compounds in its composition. In particular, the carotenoids crocetin and crocin exhibit high antioxidant activity, which inhibits the processes of lipid peroxidation, preventing rancidity of the product. The antimicrobial effect of safranal on a wide range of pathogenic bacteria and micromycetes confirms the potential of using saffron as a natural preservative. Ethnotechnological experience in using this spice in Eastern countries to extend the shelf life of food products allows us to hypothesize about increasing the microbiological and oxidative stability of the developed desserts compared to control samples.

3. Determining the amount of beekeeping products in the recipe of a curd dessert

The combination of biologically active beekeeping products with a dairy base opens up new opportunities for creating functional desserts. This approach is justified both from the standpoint of nutrition and in view of current consumer trends. Firstly, curd desserts are a powerful source of protein, and bee products add "fast" and "medium" energy (glucose, fructose) to this base. The result is an ideal product for recovery after physical exertion, where milk proteins serve as building blocks, and honey carbohydrates help these proteins to be better absorbed.

Secondly, bee products, in particular honey, have natural antiseptic properties. Organic acids in honey and enzymes (for example, glucose oxidase) inhibit the development of pathogenic microflora. In desserts with a high pH, this helps to stabilize the product and naturally prolong its freshness without the use of synthetic preservatives.

Thirdly, dairy products are poor in some trace elements (for example, iron, manganese) and B vitamins in high concentrations. Pollen and bee pollen act as natural vitamin and mineral premixes. Adding only 3–5% of perga to a curd dessert turns it into a functional product that covers a significant part of the daily requirement for potassium, magnesium, and trace elements.

Fourth, improving structural and mechanical properties, since honey acts as a natural plasticizer and moisture retainer. In a mixture of Ricotta cheese and curd, honey helps to bind free moisture, preventing syneresis. This makes the texture of the dessert more uniform, tender, and buttery.

Fifth, the organoleptic perfection of the finished product. The use of beekeeping products allows you to abandon white refined sugar and artificial flavors. The combination of the lactic acid of the cheese, the sweetness of honey, and the specific aroma of saffron creates a multifaceted taste that cannot be reproduced synthetically.

Based on commodity research, acacia honey was chosen. It has the most neutral taste among all varieties. It does not interrupt the delicate aroma of Ricotta and the exquisite flavor of saffron, but only delicately emphasizes them.

Acacia honey is almost colorless, which allows saffron to give the dessert a pure, bright golden color without extraneous dirty shades. Acacia honey is considered the least allergenic of all types of honey.

To establish the amount of honey for curd desserts, where honey can partially or completely replace sugar, experimental samples were made with different amounts of honey: with the addition of 10%, 20%, and 30% honey.

Adding honey in such proportions significantly changes not only the taste, but also the physical structure of the dessert based on Ricotta cheese and curd (2:1).

The obtained data from the study of organoleptic indicators are given in Table 3.

Table 3

Organoleptic indicators of curd base with different amounts of honey

Indicator	Sample 1	Sample 2	Sample 3
Appearance	Appearance Homogeneous, white-cream mass (with a slight golden hue from saffron). Surface matte	Mass becomes more glossy and shiny. Color becomes richer, closer to creamy yellow	Strong gloss. Mass looks semi-liquid. Color is bright golden
Consistency	Quite dense, holds its shape well on a spoon. The texture is delicate, the graininess is felt only from the curd	The mass becomes more plastic, more viscous and soft. It spreads more easily, but can slightly "settle" under its own weight	Semi-liquid, flowing. Due to the high concentration of sugars, the phenomenon of "liquefaction" of the curd mass occurs. The dessert has difficulty keeping its shape
Taste and aroma	Moderately sweet, with a pronounced creamy aftertaste. The aroma of saffron is clearly felt, honey is only in the background	Rich sweet taste. Honey begins to dominate the milky taste. The aftertaste is long, honey-floral. Saffron and honey merge into a single intense aroma	Very sweet, almost cloying. The taste of curd is faint, it only adds sourness and a protein base. The aroma of honey prevails

The results of the study, presented in Table 3, indicate that the optimal balance indicators are obtained with the addition of 10% honey. When the concentration increases to 20%, honey begins to intensively affect the structure of the milk base proteins, changing the consistency of the product. Such a sample is advisable to use as a filling for pancakes or a topping, but for independent consumption, it has excessive sweetness. The dosage of honey at 30% is the limit: the product acquires the properties of a thick paste or sauce. Due to its high energy value, such a composition can be recommended for sports nutrition as a concentrated source of energy, which requires mandatory consumption with a sufficient amount of liquid.

We consider it advisable to use honey and pollen as a functional composition in the technology of curd desserts. The biological value of pollen is due to its unique composition, which is actually a concentrate of vital substances

necessary for the development of a living organism. For humans, and especially for athletes, pollen is a natural anabolic and immunomodulator. Pollen contains from 20% to 35% protein, which contains all essential amino acids. They are in free or easily digestible form, which allows the body to instantly use them for muscle regeneration. For athletes, pollen is an ideal component in the composition of the developed dessert, as it complements the proteins of the curd base.

Pollen is one of the richest natural products in terms of vitamin content. It contains about 28 macro- and microelements, more than 50 enzymes (amylase, phosphatase, catalase, etc.), phytohormones, phenolic compounds, and flavonoids.

For an adult, especially during physical exertion, the recommended preventive dose of pollen is 10–15 g per day. A 450 g package of curd dessert is usually designed for 1–2 doses. By giving 11.25 g of pollen, you can provide almost the full daily norm of bioactive substances in one package.

Pollen has a specific spicy-sweet taste with a slight bitterness. At a concentration of more than 4–5%, the dessert may become too specific in taste, which may not appeal to all consumers.

At 2–3%, pollen harmoniously complements honey and saffron, giving the dessert interesting nutty notes.

Pollen has the ability to absorb moisture. Since the mixture (Ricotta cheese + curd 2:1) has high humidity, a small amount of pollen will help stabilize the mass, but an excess (more than 5%) can make the dessert too dry or cause the appearance of grains.

To make the pollen better absorbed and not feel like hard grains, it is better to mix it with honey (acacia) 1–2 hours before adding it to the dessert or grind it into powder. This will allow honey enzymes to break down the pollen grain shell, making vitamins more accessible to the body.

4. Technology of curd dessert and its recipe

The technological process of producing curd dessert consists of the following stages.

Stage 1. Acceptance of raw materials and assessment of their quality.

Since the composition includes both dairy products and beekeeping products with saffron, the procedure is divided into several stages. For curd and Ricotta cheese, the presence of a refrigerator (the temperature should be +2…+6 °C). Veterinary certificates (for curd, Ricotta cheese, and honey), quality certificates, and test reports for safety indicators (antibiotics, pesticides, heavy metals). The integrity of the packaging, expiration dates and batch numbers is checked.

An organoleptic assessment of dairy raw materials is carried out. For curd and Ricotta, the color should be white or slightly creamy; the smell should be purely sour milk (without any fodder or vinegary taste); the consistency of the curd should be soft and crumbly, and that of Ricotta should be tender and pasty. Honey should be checked for signs of fermentation (foam on the surface) and foreign impurities, and saffron should be evaluated for its color intensity and characteristic aroma.

After sampling, the following analyses are carried out in the factory laboratory. For dairy raw materials, titrated acidity, mass fraction of fat and moisture, and absence of mechanical impurities are determined; for beekeeping products (honey and pollen), the moisture content in honey, diastase number, and pollen purity are determined. Since saffron is the most expensive raw material, a test for adulteration (water test) is carried out. For this, natural saffron threads, when they enter water, gradually turn it yellow, but themselves remain red. If the thread instantly turns white or turns the water dark red, it is a forgery.

Stage 2. Preparation of the curd base.

The curd is homogenized or rubbed in a colloidal mill until the graininess disappears (particle size no more than 10 microns).

Ricotta is mixed with grated curd in a vacuum mixer-cutter. Vacuuming is necessary to remove air bubbles, which extends the shelf life.

Stage 3. Activation of saffron and pollen.

50 g of saffron is poured into 50 kg of cream at a temperature of 45–50 °C. Insist for 30 minutes. For better assimilation in factory conditions, it is recommended to mix the pollen with a portion of honey (1:2) 2 hours before production for enzymatic cleavage of the grain shells.

Stage 4. Mix the ingredients according to the recipe.

Saffron infusion on cream is added to the curd base. Mixing is carried out at low speeds (no more than 60–100 rpm) so as not to disrupt the protein structure.

Stage 5. Thermization

This is a method of gentle heat treatment used in the dairy industry to extend the shelf life of raw materials or semi-finished products without significantly changing their physicochemical and organoleptic properties. Thermization can be used as an intermediate stage before the introduction of biologically active components (honey, pollen).

The temperature regime is 60–65 °C with a holding time of 15 to 30 seconds (in the flow) or up to several minutes (in the tank).

The goal is to deactivate psychotrophic bacteria and enzymes (lipases), which can cause a bitter taste during storage, while maintaining the protein structure almost unchanged.

Stage 6. Cooling and introduction of beekeeping products

After thermization, the mass must be immediately cooled to 30–35 °C. It is at this temperature that honey and pollen can be safely introduced without destroying their vitamins and enzymes.

Stage 7. Packaging

The packaging operation is the final but important stage, since it is at this stage that the tightness, presentation, and preservation of all biologically active substances of the dessert are ensured. For a dessert made of Ricotta cheese, curd, and bee products (450 g), it is recommended to use automated volumetric dosing lines.

Plastic cups (made of PP polypropylene) pass through a bactericidal treatment unit (UV radiation) to prevent microorganisms from entering. The volumetric dispenser is set to a portion of 450 g. Since the mass is thick (due to 10% honey, curd, and Ricotta cheese), piston dispensers are used, which are able to work with viscous products without destroying their structure.

The finished dessert with a temperature of 6–10 °C is fed from the mixer hopper to the dispenser. It is important not to overheat the mass to preserve the activity of pollen and saffron. The piston dispenser squeezes exactly 450 g of the mixture into a cup. To avoid the formation of air cavities inside, the glass can vibrate slightly on the conveyor. An aluminium foil (sheet) with a heat-sealable layer is placed on the glass. The process occurs under the influence of temperature and pressure for a fraction of a second. It is recommended to pack in an inert gas (nitrogen) environment. This displaces oxygen, which prevents oxidation of curd fats and honey enzymes. A transparent plastic flip-top lid is placed on top of the foil, which protects the foil from punctures and allows the consumer to close the product after the first opening.

Each package is automatically marked with the date of manufacture and batch number. The composition of the developed dessert must be indicated: Ricotta, curd, acacia honey, cream, flower pollen, and saffron. Warning: “Contains bee products” (important for allergy sufferers).

The recipe for the new dessert is given in Table 4.

Table 4

Recipe for the curd dessert “Golden Energy”

Ingredient	Weight, kg
Ricotta cheese	550.0
9% curd	275.0
Acacia honey	100.0
Flower pollen	25.0
Cream 15% fat (for saffron extraction)	50.0
Saffron	0,05
Total	1000

To calculate the calorie content of the dessert "Golden Energy", we will use the average nutritional value of the ingredients.

From the data in Table 5, it is possible to calculate the calorie content of a portion (450 g) – 772.6 kcal. Proteins 50.0 g, fats 39.9 g, carbohydrates 55.0 g.

Table 5

Nutritional value of the dessert "Golden Energy"

Ingredient	Weight (g)	Protein (g)	Fat (g)	Carbohydrates (g)	Calories (kcal)
Ricotta cheese (55%)	55.0	6.05	5.50	2.20	82.5
Curd 9% (27.5%)	27.5	4.40	2.48	0.83	43.7
Honey (10%)	10.0	0.03	0	8.00	30.4
Cream 15%	5.0	0.14	0.75	0.19	8.0
Pollen (2.5%)	2.5	0.50	0.13	1.00	7.1
Saffron	< 0.1	–	–	–	–
TOTAL per 100 g	100 g	11,12 g	8.86 g	12.22 g	171.7 kcal

Therefore, based on the research, it can be concluded that the developed dessert is recommended for athletes during recovery and in dietary nutrition. Thanks to the combination of casein (from curd) and albumin (from Ricotta), both quick and long-term saturation with amino acids is ensured. Carbohydrates are mainly represented by fructose and glucose from honey, which provide energy for training, and fats from cream and curd provide a long-term feeling of satiety. Thanks to proteins and fats, sugars from honey are absorbed gradually, without causing sharp spikes in insulin.

The main physicochemical indicators of curd desserts include titrated and active acidity, syneresis, and activity of honey diastase. The results of the research are given in Table 6.

Table 6

Main physicochemical parameters of the finished product

Indicator	15 days	20 days	25 days	30 days
Titrated acidity, °T	115	130	146	160
Active acidity	5.3	5.1	4.8	4.6
Free whey, %	0.61	1.2	3.0	5.5
Honey diastase activity, %	90	80	65	45

By the 21st day, the indicators are within normal limits, and after the 21st day (days 25 and 30), the indicators of acidity and syneresis go up rapidly, which makes the product of poor quality.

Microbiological indicators are the most important for safety, as they determine whether the product can be consumed. Since the dessert does not undergo heat treatment after mixing with beekeeping products, the microflora is in dynamic equilibrium.

The results of microbiological studies are given in Table 7.

Table 7

Main microbiological indicators of the finished product

Indicator	15 days	20 days	25 days	30 days
QMAFAnM (CFU/g)	2.1×10^4	3.4×10^5	1.9×10^6	5.6×10^7
Yeast (CFU/g)	20	54	87	110
Пліснява Mold (CFU/g)	missing	missing	missing	single ones
Coliforms	missing	missing	missing	missing

It should be noted that the norm for such desserts should not exceed 1×10^6 CFU/g. Table 7 shows that on the 15th day, the level is stable or slightly increases, and on the 30th day, the norm is exceeded.

So, according to the results of a complex study within 30 days, we recommend a shelf life of 21 days for curd dessert. Considering the composition of the product (honey, pollen, saffron, and the absence of final sterilization in the container), 21 days is the period during which the product retains the status of "premium" in all respects.

CONCLUSIONS

The paper presents a theoretical generalization and solution to a practical problem regarding the development of a functional dairy dessert technology for sports nutrition.

It was established that the use of a combined protein base (Ricotta cheese + curd in a ratio of 2:1) allows you to create a product with a balanced content of albumin and casein proteins. This provides a prolonged supply of amino acids to the muscles, which is important for the recovery phase of athletes.

Based on organoleptic and physicochemical studies, a rational dosage of functional additives was determined: 10% acacia honey, 2.5% flower pollen, and activated saffron. This combination provides high taste properties of the product without the use of synthetic sweeteners and dyes.

The technology for the production of curd dessert was improved. The introduction of a honey-pollen mixture after the stage of thermization of the dairy base was proposed. This allowed to preserve 85–90% of biologically

active substances (diastase enzyme, saffron crocin, pollen vitamins), which are usually destroyed by traditional pasteurization methods.

The nutritional value of the finished product was confirmed. It was proven by calculation and experimental methods that a portion of dessert (450 g) provides the athlete's body with 50 g of high-quality protein and a complex of natural antioxidants. The energy value of 100 g of the product is 171.7 kcal, which meets the requirements for products for restoring energy expenditure.

Based on a comprehensive study of the dynamics of indicators (for 1, 15, 20, 25, and 30 days), it was established that critical changes in quality begin after the 21st day of storage. It is proposed to set a period of 21 days at a temperature of 4–6 °C.

SUMMARY

The work is devoted to the scientific substantiation and development of recipe and technological solutions for the production of an innovative protein dessert for sports nutrition.

The work analyzes the raw material base for the production of a new product. The feasibility of combining Ricotta (a source of albumins) and curd (a source of casein) to create an optimal amino acid matrix necessary for the recovery of athletes is proven. The use of acacia honey, flower pollen and saffron as multifunctional additives that increase the biological value and antioxidant potential of the product is proposed.

The optimal dosage of ingredients is experimentally established: 10% honey, 2.5% pollen and activated saffron extract. The organoleptic, physicochemical and microbiological indicators of the product during storage are studied. The technology for the production of curd dessert is improved. It has been established that the use of “clean packaging” technology and the natural preservative properties of additives allows for a shelf life of 21 days at a temperature of 4–6 °C.

The nutritional value has been calculated: a portion of dessert contains 50 g of protein, which meets the needs of professional sports nutrition.

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