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GOAT MILK YOUGURT AS A POTENTIALLY FUNCTIONAL FOOD[6]

Assoc. Prof. Cristina Popovici, PhD
Department of Food and Nutrition, Faculty of Food Technology
Technical University of Moldova
E-mail: cristina.popovici@toap.utm.md

Renata Brînza, BSc Student
Department of Food and Nutrition, Faculty of Food Technology
Technical University of Moldova
E-mail: renata.brinza1@gmail.com

Anatoli Cartasev, Young Scientist
Olga Migalatiev, Young Scientist
Nina Bogdan, Young Scientist
Laboratory of Food Biotechnology, SPIHFT, Moldova

Roman Golubi, Young Scientist
Laboratory of Food Quality Assuarance, SPIHFT, Moldova

Irina Grumeza, Young Scientist
Ghenadie Coev, PhD
Vavil Caragia, PhD
Laboratory of Food Technology, SPIHFT, Moldova

Abstract: *Recently, there is a growth in the usage of goat's milk products, which have valuable nutritional properties for humans and can be positioned as a healthy diet product. Goat milk and goat's milk dairy products can be used as a part of a therapeutic nutritional program for all categories of the population as well as for kids and cow's milk sensitive people. In this study goat milk was analyzed for chemical composition. The research also includes recipes and technological schemes developed for the production of yoghurts from goat milk with increased nutritional value due to the introduction of industrial tomato waste CO_2 - extract containing such antioxidants as beta-carotene, lycopene and tocopherol. The antioxidant activity of the extract was determined by the DPPH free radical method. The obtained yoghurts were analyzed in terms of chemical composition and organoleptical properties.*

Key words: *goat milk, yoghurt, CO_2 - extract, chemical composition, biological properties.*

INTRODUCTION

Goat milk has a promising source of protein, vitamins, minerals and fatty acids (Asresie A. & Adugna M., 2014; Beshkova D.M., Simova E.D., Dimitrov Zh.P. & Simov Zh.I., 2011; Domagała J., 2008). Goat milk has better digestibility, reduced allergenicity, due to the low content of lactose (Hassan F.A.M., Abbas H.M., Abd El-Gawad M.A.M. & Enab A.K., 2014; Paz N.F., Oliveira E.G., Kairuz M.S.N. & Ramon A.N., 2014). From goat milk usually is obtained butter, yogurt, sour milk, etc. Fermented dairy products have delicious sensory properties, fine consistency and pleasant specific taste. Especially fermented goat milk products have significant commercial potential, large destination and multiple health benefits for population. Considering the importance of fermented dairy products from goat milk, which are in demand on internal and external markets, elaboration of the technological process for manufacturing of the products is necessary.

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Internationally the theme proposed for research is carried out on the preparation and optimization of manufacturing technology of yougurt from goat milk (Aswal P., Shukla A. & Priyadarshi S.,2012; Garcia V., Rovira S., Boutoial K. & Lopez M.B., 2014; Ribeiro A.C. & Ribeiro S.D.A., 2010. There are also conducted research on the analysis of physical-chemical, microbiological and sensorial properties of yougurt from goat and cow milk (Serhan M., Mattar J. & Debs L., 2016). There are comparative studies on influence of the incorporation of synthetic and natural preservatives on the yoghurt characteristics (Caleja C., Barros L., Antonio A.L., Carocho M., Oliveira M.B.P.P. & Ferreira I.C.F.R., 2016. Some researchers conducted studies regarding the improvement of goat milk yougurt by adding aromatic oils and plant (Abou Ayana I.A.A. & Gamal El Deen A.A., 2011. The study conducted by scientists from Bulgaria showed the possibility of yougurt supplimentation with fruit juice (Boycheva S., Dimitrov T., Naydenova N. & Mihaylova G., 2011. Documented results are aimed to understand the correlation between fortification with shell pineapple and physico-chemical and rheological properties of yogurt with probiotics (Saha B.N.P., Vasiljevica T., McKechnieb S. & Donkor O.N., 2016). The results of researchers from Sri Lanka have shown that incorporation of beetroot juice can be an insight to improve the characteristic organoleptic properties of goat milk (Abou Ayana I.A.A. & Gamal El Deen A.A., 2011. A group of scientists studied the effect of Cinnamomum verum yogurt fortification with Allium sativum and the bifidobacteria (Shori A.B. & Baba A.S., 2015).

The aim of this study is to develop and diversify fermented goat milk products with functional potential, by adding lactic acid bacteria obtained from natural sources with symbiotic properties and bioactive compounds.

MATERIALS AND METHODS

Materials

As components for obtaining experimental samples of yougurt, goat milk, starter culture, fruits (apple and prunes), sugar, cinnamon and vanilla CO_2 - extract of industrial tomato waste were used. Tomato waste was collected from the industrial scale production of tomato juice at "Orhei-Vit" JSC, Orhei, Republic of Moldova. All materials used correspond to requirements for quality of the specifications and technical documentation.

Chemicals

1,1-Diphenyl-2-picrylhydrazyl (DPPH) as free radical form (95% purity) was supplied by Sigma-Aldrich. Ethanol (99.9%), methanol (99,8%), chloroform, glacial acetic acid, potassium hydroxide, phenolphthalein, potassium iodide, sodium thiosulfate (Na2S2O3 × 5H2O) and starch were provided by Eco-Chimie Ltd (Chisinau, Moldova). All the chemicals used were of HPLC or analytical grade. Distilled water was used throughout.

Supercritical CO_2 extraction

The supercritical extraction with carbon dioxide from tomato waste was carried out under laboratory conditions at the HA 120-50-01C pilot plant. The technical parameters of the installation are: P_{max}=50 MPa (500 atm), T_{max}= 75°C, volume of the extractor vessel –1,0 l and maximum extract volume–0,6 l. From the storage tank, the carbon dioxide is pumped through the heat exchanger into the extractor vessel with raw material –tomato waste.

Using the pressure and temperature control system the required extraction pressure and temperature were created in the extractor vessel. Once the supercritical CO_2 and the feed reach equilibrium in the extraction vessel, through the manipulation of pressure and temperature to achieve the operating conditions, the extraction process proceeded. The mobile phase, consisting of the superctitical CO_2 fluid and the solubilized components, is transferred to the separators I and II where the fluid is reduced by decreasing the pressure of the system. The extract precipitates in the I or II separator while the superctitical CO_2 fluid is either released to the atmosphere or recycled back to the extractor.

DPPH Assay

The radical scavenging activity of CO_2 – extracts from tomato waste as well as the kinetics of inhibition of free radicals were studied in terms of radical scavenging ability using the stable DPPH$^{\bullet}$

method. 0.1 ml of the extract sample was added to 3.9 ml of 60 μM solution of $DPPH^{\bullet}$ in methanol. The reaction was carried in dark and the absorbance was recorded at 515 nm to determine the concentration of remaining $DPPH^{\bullet}$. Methanol as instead of $DPPH^{\bullet}$ solution was used as blank solution. The values of $[DPPH^{\bullet}]$ at each reaction time were calculated according to the standard curve. The reaction was carried in dark and the absorbance was recorded at 515 nm to determine the concentration of remaining $DPPH^{\bullet}$. Methanol as instead of $DPPH^{\bullet}$ solution was used as blank solution. The values of $[DPPH^{\bullet}]_t$ at each reaction time were calculated according to the standard curve. Concentration range of DPPH was of 0.38-38 μg/ml (A_{515} nm = 0.0293 $[DPPH^{\bullet}]_t$ – 0.0072), where the concentration $[DPPH^{\bullet}]_t$ is expressed in μg/ml). The coefficient of linear correlation of the above relation is R = 0.9999. The radical scavenging activity (RSA) was calculated using the equation:

$$RSA = 100\% \bullet ([DPPH^{\bullet}]_0 - [DPPH^{\bullet}]_{30}) / [DPPH^{\bullet}]_0$$

where $[DPPH^{\bullet}]_0$ is the concentration of the $DPPH^{\bullet}$ solution (without sample) at t=o min and $[DPPH^{\bullet}]_{30}$ is the remained $DPPH^{\bullet}$ concentration at t=30 min. Lower $[DPPH^{\bullet}]_t$ in the reaction mixture indicates higher free radical scavenging activity.

Chemical composition

The quantification of ashes, fat content and proteins was carried out in the goat milk and yougurt samples according to the AOAC Official Methods AOAC 16.006, AOAC 945.16 and AOAC 958.48 respectively. All the determinations were performed in duplicate.

Statistical analysis

Variance analysis of the results was carried out by least square method with application of Microsoft Office Excel program. Differences were considered statistically significant if probability was greater than 95% (q < 5%). All assays were performed at room temperature, 20 ± 1ºC. Experimental results are represented according to standard rules.

RESULTS AND DISCUSSION

Analysis of antioxidant properties of tomato waste extracts

In this study was used a tomato waste extract, developed by the Institute of Food Technologies of the Republic of Moldova in the framework of the Food Technology Laboratory under the guidance of Professor Vavil Caragia (Migalatiev O., 2017; Popovici C., Migalatiev O. *et al.*, 2017; Popovici C., Migalatiev O. *et al.*, 2018).

Fig. 1. Appearance of tomato waste and their extract used in the study

For the used tomato waste extract, was taken the UV spectrum, on which peaks of such biologically active substances as polyphenolic compounds (380 nm), beta-carotene (420-480 nm) and tocopherol (680 nm) were recorded. The resulting spectrum is shown in Fig. 2.

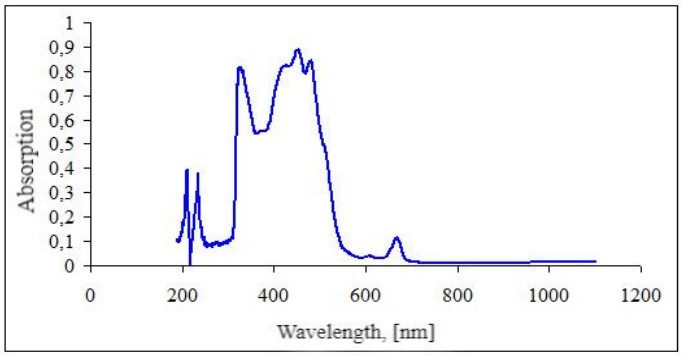

Fig. 2. UV spectrum of the tomato waste extract

Subsequently, in the study was analyzed the antioxidant activity of the extract, the interaction in time, of the free radical of DPPH and the extract is shown in Fig. 3.

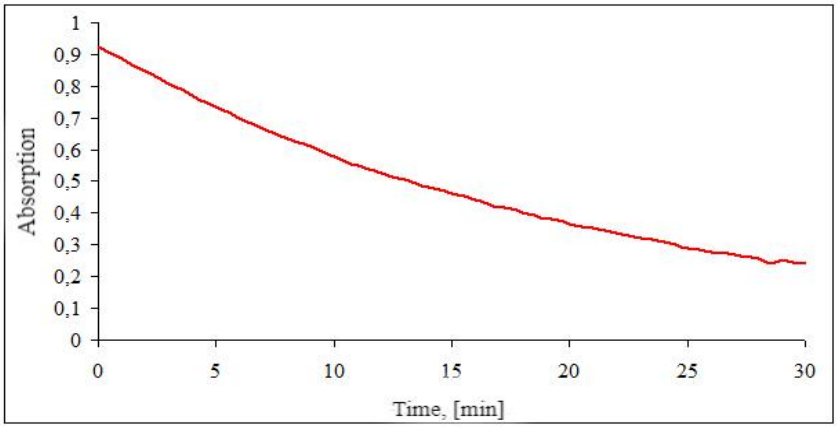

Fig. 3. The interaction in time of the free radical DPPH and the extract

Based on the obtained experimental data, the antioxidant activity of the DPPH tomato waste extract was calculated, which value is 87.5%. Subsequently, the studied extract was used in developing the yoghurt recipes based on goat milk and flavoring food ingredients.

Analysis of the chemical composition of goat milk

In this study, a comparative analysis of the fat, protein, fat and ash content of the goat milk was made. Table 1 presents experimental data on the chemical composition of goat milk.

Table 1. The chemical composition of goat milk, g / 100g

№	Indicator name	Content, g
1.	Protein content, g	3,35±0,01
2.	Fat content, g	1,5±0,02
3.	Lactose content, g	4,52±0,01
4.	Ash content, g	0,8±0,01

The lactose content of raw goat milk was determined in accordance with the standard method ISO 22662: 2007, which provides high performance liquid chromatography (HPLC) with refractometric detection.

The recipe development and technology for obtaining goat milk yoghurt

Goat milk, given its chemical composition is more valuable, compared to cow's milk. Because of the goat milk proteins and fats molecule structure, these substances are easily absorbed by the human body. A special interest have hypoallergenic and biological properties of goat milk.

The technology of goat's milk products requires serious theoretical and practical elaboration. High-tech food products based on goat milk, cheeses, yoghurts and other protein products can provide a rational, full and healthy diet for the population.

As a result of the enzymatic activity of the probiotic microorganisms of the starter, the protein and carbohydrate component of goat's milk is modified, which facilitates the easy assimilation of goat yoghurt by the body. Goat yoghurt is a source of calcium and phosphorus, contains valuable animal protein, a number of vitamins (B_2 and B_{12}) and mineral compounds (copper, potassium, magnesium, selenium). Included in the composition of the starter microorganisms contribute to the normalization of the intestinal microflora inhibiting the development of decay processes.

The tomato waste extract addition enriches the biological value of this product due to contained in it lycopene, beta-carotene, tocopherol and polyphenolic compounds.

In this study, recipes and appropriate samples of yoghurts based on goat milk were developed. These formulations are presented in Table 2.

Table 2. Recipes of yoghurt samples (yield 100 g)

Ingredients	*Samples of the studied yoghurt*				
	Cow milk yoghurt	Goat milk yoghurt	Goat milk yoghurt with vanilla	Goat milk yoghurt with apple and cinnamon	Goat milk yoghurt with prunes and vanilla
Cow milk	90	-	-	-	-
Goat milk	-	82	82	72	72
Tomato waste extract		3	3	3	3
Starter culture	10	10	10	10	10
Apple paste	-	-	-	10	-
Prunes paste	-	-	-	-	10
Sugar	-	-	4	4	4
Cinnamon	-	-	-	1	-
Vanilla	-	-	1	-	1
Total:	100	100	100	100	100

The investigated yoghurt samples were examined for protein, fat and ash content. The experimental obtained data are presented in Table 3.

Table 3. Chemical composition of the studied yoghurts

Ingredients	*Samples of the studied yogurt*				
	Cow milk yogurt	Goat milk yogurt	Goat milk yogurt with vanilla	Goat milk yogurt with apple and cinnamon	Goat milk yogurt with prunes and vanilla
Protein content, g	2,5±0,1	2,5±0,2	2,5±0,1	2,5±0,1	2,5±0,2
Fat content, g	1,5±0,2	1,5±0,1	1,5±0,1	1,5±0,1	1,5±0,1
Ash content, g	0,7±0,1	0,7±0,1	0,7±0,1	0,7±0,2	0,7±0,2

The study of the organoleptic properties of yogurt from goat's milk

In this study, an organoleptic evaluation of the quality of the yoghurt samples was performed. During the analysis of this product, a tasting commission was created. To each tasting participant was presented a special developed tasting sheet, samples of yoghurts in plastic, disposable cups and mineral water.

Based on the described organoleptic standard characteristics for yoghurts, it can be said that in appearance and consistency, yoghurt should be a homogeneous mass, moderate viscous, with the

addition of thickening agents or stabilizing additives - jelly or creamy. Inclusions of insoluble particles characteristic for the introduced components are allowed. Smell and taste is characteristic to a sour milk, without foreign flavors and smells, moderate sweet taste (when working with sweetening ingredients), with the appropriate taste and flavor of the introduced ingredients. The color, according to the standard, must be milky white or of the color of induced components, homogeneous or interspersed with insoluble particles

Based on the received data from the tasting commission, estimates were made for each quality index of the tested yoghurt samples, which are shown in Fig. 4.

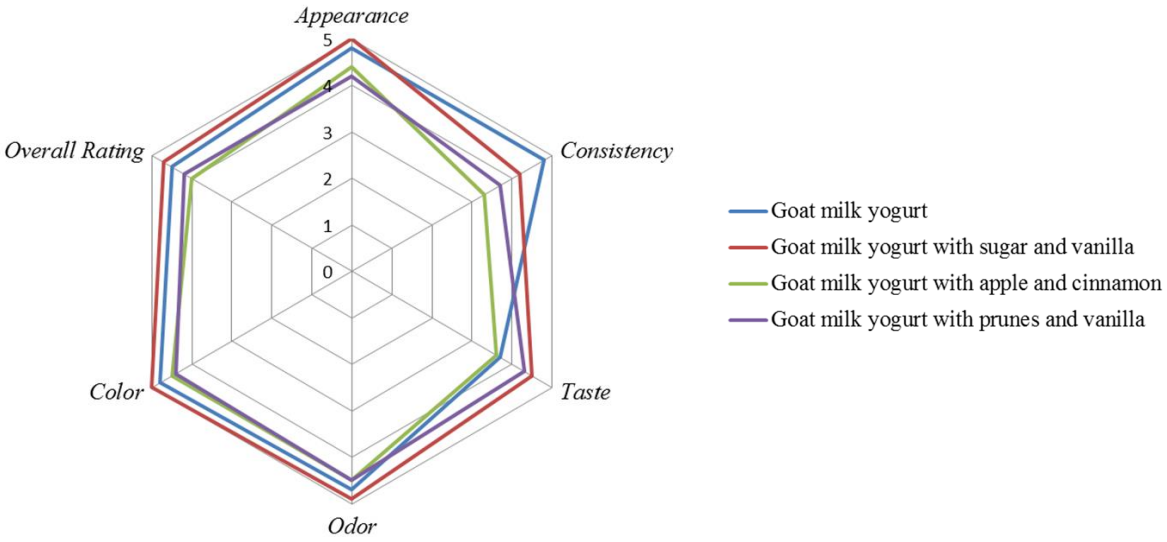

Fig. 4. General diagram of organoleptic evaluation of yoghurt

According to Fig. 4, which was made on the data obtained from the tasting commission, we can conclude that the most acceptable yoghurt from goat milk is yoghurt with the addition of sugar and vanilla. Almost all members of the commission gave their preference to this type of yoghurt, describing it as the most delicious yoghurt. As for the apple and cinnamon yoghurt and prunes and vanilla yoghurt samples, the commission gave them the same preference, but to a lesser extent in comparison with the sugar and vanilla sample.

CONCLUSIONS

In this study, the antioxidant activity of the tomato waste extract was determined, which was 87.5%. The interaction between the extract and the free radical DPPH was also analyzed. The chemical composition of the goat milk sample was determined, namely, the protein content is 3.35 g / 100 g, the fat content is 1.5 g / 100 g, the lactose content is 4.52 g / 100 g and the ash is 0.8 g / 100 g. Formulations and technology of goat milk yoghurt production with the introduction of tomato waste extract and flavoring food ingredients such as apple paste, prunes, cinnamon, vanilla, sugar have been developed. The organoleptic properties of the obtained yoghurt samples were evaluated, which showed that yoghurt from goat milk with addition of sugar and vanilla, apple paste and prunes possesses the most pleasant flavor properties. The chemical composition of the yogurt was determined, namely the protein content was 2.5 g / 100 g, fat 1.5 g / 100 g and ash 0.7 g / 100 g.

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