

ANALYSIS OF THE NUTRITIONAL PROFILE AND OF THE FUNCTIONAL DEGREE OF THE YOGURT WITH BLACKTHORNS FRUITS (PRUNUS SPINOSA)

Mariana BEI¹, Camelia BARA¹, Eugen JUDE¹, Lucian BARA¹, Cornelia PURCĂREA^{1#}, Cristina ROȘAN¹

¹University of Oradea, Faculty of Environmental Protection, Oradea City, Magheru 26, 410087, Romania Institution

RESEARCH ARTICLE (REVIEW ARTICLE)

Abstract

The food that contains increased quantities of antioxidant substances of the polyphenols and tannins type manifest functional actions in preventing and improving the pathological status induced by the oxidative stress.

This study was conceptualized with the purpose of improving the nutritional profile of some dairy products like yogurt by adding blackthorn fruits with function potential having as purpose the offering of a complete or additional nutritional support to some categories of the population.

*The blackthorns (*Prunus spinosa* L), were chosen due to the antioxidant capacity of these forest fruits, used so little by the consumers despite the very accessible ecological areal of culture and without costs. The requests and preferences of the consumers for these forest fruits are reduced, it seems because of the liminal knowledge about their functional qualities.*

The approach of the different alternatives of preparing the yogurt with blackthorns admixture for the increasing of the functionality degree has as premises the improving of some metabolic functions that would induce an increase of the level of health, reducing the risk of incidence of some diseases.

By this study we want to develop new food products that would satisfy the requests of the consumers from the nutritive-functional point of view and from the point of view of the food obtained from ecological ingredients, more and more attractive for the potential consumers.

*Based on the results obtained we consider the blackthorns (*Prunus spinosa* L) as being a useful ingredient for the nutraceutical industry and for the food industry, due to its antioxidant and antimicrobial effects on some Gram-negative and Gram-positive bacteria with pathogenic potential.*

Keywords: blackthorn; phenolic compounds; antimicrobial; antioxidant, functional components, metabolic effect

#Corresponding author: prcneli@gmail.com

INTRODUCTION

The blackthorns are forest fruits very seldom used in the food despite the fact that they have the most important benefits for the health due to their nutritional components seldom met in other forest fruits. They contain the largest quantities of tannin and the most significant quantities of: flavonols, flavonoids, quercetin, polyphenols, anthocyanins, hydrogen cyanide glycosides and glycosampherosides, kaempferol, organic acids, sugars, plum cyanine. They contain salts of Calcium and Magnesium, Potassium, Phosphorus, Iron, Copper, Sodium. In the blackthorns fruits were identified also some vitamins as amygdalin (vitamin B₁₇), provitamin A, K, vitamins B₁, B₂, PP (niacin or B₃), vitamin C, tocopherols, fatty acids, sitosterol, amino acids and carbohydrates (Najgebauer-Lejko et al., 2021). These components have a great potential as supplements for food like yogurt, in which they act as antioxidants and natural alternatives for the colorants and synthetic flavors.

According to the data presented in the specialty literature, the most representative anthocyanins in the juice of the fruits of *Prunus spinosa* are cyanidin-3-rutinoside, peonidin-3-rutinosid and cyanidin-3-glucoside with an important antioxidant role (Fraternal et al., 2009).

Their energetic value is of approx. 56 kcal/100 g.

These valuable nutritional characteristics of the blackthorns fruits allows them to be included in the yogurt formula obtained by modifiable methods and the different ingredients included in the yogurt formula, as the sugar or other sugar substitutes, probiotic cultures, stabilizers, aroma and many other nutritive substances and functional components lead to the diversification of this assortment (Aryana and Olson. 2017; Tamime and Robinson, 1999). The yogurt can be produced in different versions to satisfy the most demanding requests of different consumers.

The yogurts with fruit aroma are more popular than the natural ones.

The food obtained by home-made methods is considered more and more healthier which determines the food producers to develop new food products. They return more and more to the natural products and the traditional recipes more attractive for most of the possible consumers (Aryana and Olson. 2017; Tamime and Robinson, 1999).

In the present the consumers search for new tastes and flavors, pay attention to the origin and bioactive properties of the food, amid the awareness of the way in which a food structure can affect their health and wealth.

The blackthorns fruits were used in the popular medicine for different purposes, as: healing the flu, some forms of cold, diabetes or cardiovascular diseases (Natić, et al 2019; Ürkek, et al 2019). In this regard there were proposed different mechanisms to explain the antioxidant activity of the anthocyanins, as would be the capacity to capture the free radicals (Terevinto and collab., 2010; Erturk and collab., 2009), to chelate the metallic ions, to inhibit the oxidation of the lipoproteins (Varga and collab., 2017; Radovanović, and collab., 2013) and to form complexes with DNA (Baltas and collab., 2017).

Ürkek et al 2019 has disclosed that the blackthorns fruits can be added in the food like icecream as colorants, flavoring and antioxidant additives and as agents of increase of viscosity.

In the experiments in which was evaluated the antioxidant activity of the fresh juice of blackthorns (PJ) on the cellular level in case of the oxidative stress. In the pro monocitary cells exposed to H_2O_2 , it was registered a valuable antioxidant activity, being capable to protect the cells from the oxidative stress in a manner of dose-response.

The fresh juice of blackthorns (PJ) was used in the same way in the versions without cellular impairment, in which the selected concentrations (up to 0,01%) were not cytotoxic per se. In the selected conditions of exposure the treatment with 0,3 mM H_2O_2 has determined a significant reducing of the surviving cells and, according to the observations previously published, the model of cellular death was mainly necrotic.

The fruits and juice of *Prunus spinosa* could be considered a valuable source of antioxidant compounds for nutritional supplements and for the nutraceutical herbal therapies.

The data obtained up to the present have reported a total content of polyphenols

and anthocyanins that contribute significantly to the antioxidant activity of the blackthorns fruits due to the rich content of cyanidin-3-rutinoside (53,5%), peonidin-3-rutinosid (32,4%) and cyanidin-3-glucoside (11,4%).

Elisia and collab. 2007 have observed that cyanidin-3-glucoside has demonstrated an important antioxidant efficiency in the „in vivo” models and in the „in vitro” models compared to other 13 tested anthocyanins; moreover the anthocyanins, compared to other classic natural antioxidants, were recognized as dominant inhibitors of the peroxidation of the lipids (Zafra-Stone and collab., 2007).

MATERIAL AND METHOD

The blackthorns are small stone fruits, spherical, of indigo color, covered with bluish bloom, of the size of a small cherry, with pulp adherent to the kernel, green, acid and acute astringent.

The analysis of the nutritional profile and the higher functional properties gives to these fruits the nature of food rich in phenolic compounds and other bioactive compounds.



Figure 1. *Prunus Spinosa* – Physiology of the plant

The fruits are harvested from the pure environment without polluters, having the nature of a food rich in phenolic and anthocyanins compounds.



Figure 2. Yogurt obtained by Homemade techniques

The samples of yogurt were represented by the 0% fat yogurt taken from the stores and homemade yogurt from cow milk. The yogurt thus obtained was degreased to 2% fat. The yogurt was chosen due to the popularity as a fermented diary product, used not only for its

taste but also for its nutritional, functional properties and of promoting of health.

The nutritional quality of the yogurt with added blackthorns was evaluated based on the content of bioactive compounds: polyphenols (TPC), vitamin C, lipid content.

The analysis was performed on the fresh sample without thermal treatment.

Conținutul total de fenoli (TPC) – was analyzed by the Folin-Ciocalteu spectrophotometric method measuring the absorbancy at 765 nm, using as standard the galic acid.

The content of vitamin C (ascorbic acid) was determined using the spectro-photometric method with xilen extraction (Rangana, 1986), because in the case of the fruits with a content of anthocyanins the titrimetric method can't be applied precisely. It was accomplished a curve of calibration using a stock solution of ascorbic acid 0.1mg/ml, prepared in metaphosphoric acid 3%.



Figure 3. Determination of the content in fat and of the content in polyphenols

The content in fat of the yogurt obtained by homemade methods was determined by the Gerber acido-butirometric method.

The determination of the nutritional profile and of the functional degree was based on the determination of the real nutritional value and of the nutritional-functional effect on some metabolic parameters.

RESULTS AND DISCUSSIONS

From the nutritional point of view in this study was intended the underlying of the impact and the role of the nutrition on the metabolic parameters that concur to the maintaining and improving the health. The study has allowed the evaluation of the functional degree of some dairy products like yogurt by adding blackthorns fruits. These fruits were chosen due to the content in polyphenols and anthocyanins. The high content in functional compounds lead to the improving of

the functional degree, offering complete and additional support for some categories of the population.

The nutritional profile allows the innovation of new products considering also the food habits and traditions, the health condition so that a food product taken by itself would have an important role in the global food diets.

Based on the results obtained we want to develop new food products in order to satisfy the increased requests for functional food obtained from ecological ingredients appreciated by the possible consumers in search for something else. This fact could bring benefits in the implementing and/or adopting a diversified nutritional plan, in the case of the healthy consumers and also in the case of mono or poly-affected consumers, correlated with the requests for food of the human body.

Table 1
Comparative distribution of the energetic value and of the content in nutrients of the yogurt samples

Analyzed Nutrient (g/100g)	Yogurt 2%	Yogurt 0%
Proteins	3,30	3,96
Lipids	2	0,1
Carbohydrates	4,68	5,56
V.E.	51,32	39,97

Legend: V.E. energetic value kcal

The content of proteins and carbohydrates varies inversely proportional with the content of lipids. It is observed an ascendant evolution of the calories content correlated significantly with the content of lipids (table 2).

The content in saturated fats related to the total content of fats was 62,5% in the home made prepared and degreased sample (figure 4), being smaller compared to the yogurt sample with 0,1% fat in which the saturated fats were in a percentage of 64,16% from the total fats.

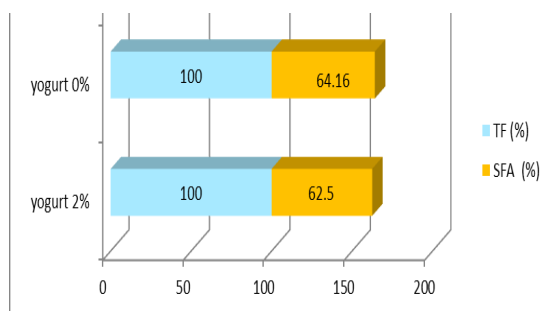


Figure 4 Distribution of the content of saturated fats (SFA) from the total fats (TF) from the yogurt samples (%)

Table 2

Distribution of A_{Ia} depending on the MCT saturated fat acids and essential fat acids from the yogurt samples

Analyzed product	Quantity (g)	Total L (g/day)	SFA (g/zi)	Lipids							A _{Ia}
				MCT			MUFA/PUFA (mg/day)				
				C12:0	C14:0	C16:0	ω ₉	ω ₆	ω ₃	ω ₆ /ω ₃	
				Lauric	Miristic	Palmitic					
Yogurt 2%	120	2,4	1,50	0,066	0,210	0,696	0,672	0,074	0,009	7,4:1	2,12
Yogurt 0%	120	0,12	0,077	0,0036	0,028	0,088	0,078	0,0072	0,0036	2:1	2,32

Legend: L- lipid, SFA- saturated fats, MCT – triglycerides with medium chain, MUFA – mono-nonsaturated fats, PUFA – poly nonsaturated fats, A_{Ia} – atherogenic index

In the nutritional studies the determination of the quantity of saturated fat from the total fats, represents an important parameter in the evaluation of the nutritional profile. The best report ω_6/ω_3 (table 2) was registered in the sample of yogurt 0,1% fat, in the yogurt prepared home-made and degreased, report ω_6/ω_3 , was of 7,4:1

The atherogenic index (A_{Ia}) was not situated in the nutritional recommendations that provide that this parameter would be between 0,38-0,39. These values of 2.12 and 2.32, respectively, are due to the content of MCT fats (triglycerides with medium chain) which in the cardiovascular pathologies associated with obesity and diabetes are considered factors of risk (figure 5).

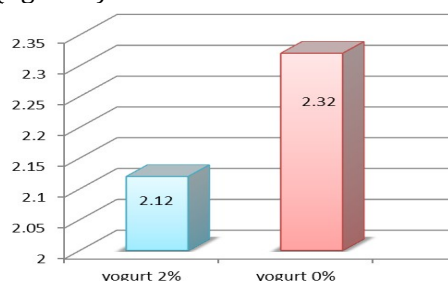


Figure 5. The distribution of A_{Ia} (%) in the simple yogurt

The content of blackthorns in vitamin C, (table 3) was in average of 24.61 mg /100 g of fruit, assuring 32,81% of DZR.

Table 3
Content in vitamin C of blackthorns *Prunus spinosa*

No. crt.	abs	Conc mg/100 ml extract	Conc mg/100g FW
P1	0.737	11.5029	23.01
P2	0.703	12.4799	24.96
P3	0.687	12.9397	25.88
Average		12.3075	24,61

The total content of fats has registered a decrease, an important aspect to be seen

The concentration in polyphenols was in average of 932,7 mg/100 g, quantity that sustains the remarkable antioxidant power of these fruits (table 4).

Table 4
The content in polyphenols of the blackthorns *Prunus spinosa*

	abs	c $\mu\text{g/ml}$ extract	c*d ($\mu\text{g/ml}$ extract)	mg/100g sample
P1	2.165	242.91	4858.16	971.63
P2	2.089	234.17	4683.44	936.68
P3	1.987	222.44	4448.96	889.79
Average		233,17	4663.52	932,7

According to the specialty literature, the incorporation in the yogurt formula of different fruit products (pulp, juices etc.) increases the antioxidant potential of the fermented milk because the fruits are an exceptionally rich source in antioxidant substances, like polyphenols, vitamin C and other vitamins and carotenoids (Quereschi and collab, 2015; Najgebauer and Sandy, 2015).

The admixture of 20 g of blackthorns, has given a strong effect of improvement of the nutritional profile, A_{Ia} being between the recommended values, of 0.38-0.39

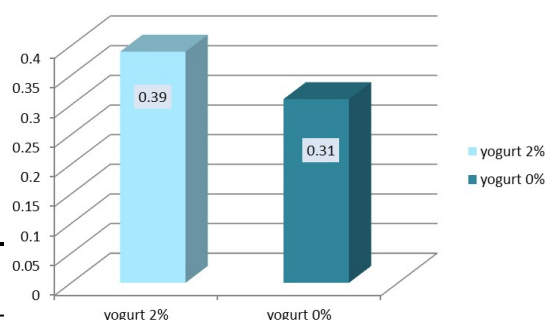


Figure 6. Distribution of A_{Ia} (%) in the blackthorns yogurt

because the admixture of sloes leads to the decrease of the total quantity of lipids, bringing

a balance in the content of fatty acids from the omega 3 class present in these fruits (figure 7).

Yuksel, 2015 in the study regarding the „effects of the admixture of blackthorns, pieces (Prunus Spinosa L.) on some characteristics of quality of the icecream”, has observed an increase of the titrable acidity, of the viscosity, of exceeding the time from the first drip and of complete melting, while the total content of fats, proteins, pH has decreased. The increase of pieces of blackthorns fruits concentration has lead to the increase of the positive effects on the majority of the parameters of quality observed in all the ice cream samples (Yuksel, 2015).

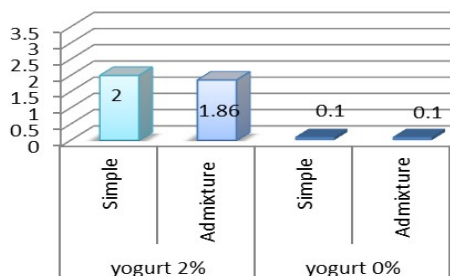


Figure 7. Distribution of the content of fats in the yogurt samples

The admixture of 20 g of sloes has led to the balancing of the content of fatty acids from the omega 3 class, present in these fruits, even if in small quantities, thus enriching also the report omega 6:omega 3. This report being with major nutritional significance because, with value larger than 4, omega 6 can manifest pro inflammatory effect.

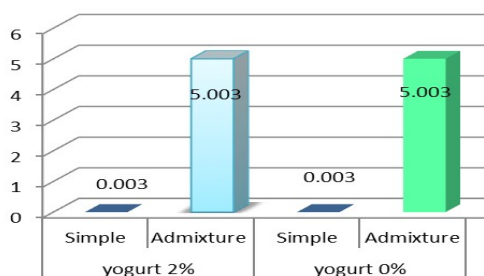


Figure 8. Distribution of the content of Vitamina E in the yogurt samples

In the simple yogurt, vitamin E, an important antioxidant from the nutritional point of view, is present under the form of traces 0,03 UI/100 g, and after the admixture of blackthorns the content in vitamin E reached 5,03 UI/100 g (figure 8)

By adding a quantity of 20 g of sloes in the yogurt samples it was observed the improving of the report omega 6 / omega 3, it was identified a significant content of vitamin C, which in the simple yogurt is non existent and the content of vitamin E and the content of polyphenols specific to the blackthorns fruits give this product higher functional properties and a remarkable antioxidant capacity.

CONCLUSIONS

The nutritional profile of a food represents a parameter that defines the nutritional functional quality, written on the label of the food.

In designing and homologation for some food products, especially for dietetic functional designation, the nutritional profile and the functional degree represents a main parameter of analysis by which the finished product could improve the health condition.

The blackthorns fruits, a limitless source of natural functional ingredients, can have the potential to offer benefic effect for the health due to their antioxidant activity and the total content of phenolic and flavonoid compounds.

We consider the fortification of the degreased and partially degreased yogurt, with blackthorns under different forms, a striking method in the food industry because of the anthocyanins which improved significantly the nutritional profile and which receive an applicability wider and wider in the food industry.

The results have demonstrated that the sloes possess a great potential for the production of functional food, representing good resources of bioactive compounds like phenolic compounds and minerals, with an increased efficiency in fighting the harmful action of the free radicals and the stopping of the pro-oxidant processes promoting some pathologies in an alarming growth.

The yogurt is a food product of greater interest, accessible and convenient to be consumed by all the groups of age, which makes the consumption of yogurt with admixture of fruits with antioxidant capacity, a feasible approach to improve the nutritional condition of the population in general.

The results of the study regarding the fortification of the yogurt with blackthorns is encouraging and suggest that this product could play a sustainable role in improving the nutritional condition of the persons with metabolic pathologies.

ACKNOWLEDGMENTS

REFERENCES

- Aryana, K.J.; Olson, D.W. A 100-year review: Yoghurt and other cultured dairy products. *J. Dairy Sci.* **2017**, *100*, 9987–10013. [CrossRef]
- Baltas, N.; Parkyldiz, S.; Can, Z.; Dincer, B.; Kolayli, S. Biochemical properties of partially purified polyphenol oxidase and phenolic compounds of *Prunus spinosa* L. subsp. *Dasyphylla* as measured by HPLC-UV. *Int. J. Food Prop.* **2017**, *20*, 137
- Elisia I, Hu C, Popovich DG, Kitts DD. (2007) Antioxidant assessment of an anthocyanin- enriched Najgebauer-Lejko D, Liszka K, Tabaszewska M, Domagala J. Probiotic Yoghurts with Sea Buckthorn, Elderberry, and Sloe Fruit Purees. *Molecules*. 2021 Apr 17;26(8):2345. doi: 10.3390/molecules26082345. PMID: 33920663; PMCID: PMC8074036.
- Qureshi, T. M.; Nadeem, M.; Ahmad, M.M.; Hussain, S.; Rehman, S.; Shaukat, A. Antioxidant potential of natural fruit flavored yogurt-a review. *Pak. J. Agric. Res.* **2017**, *55*, 85–99.
- Tamime, A.Y.; Robinson, R.K. *Yoghurt Science and Technology*, 2nd ed.; Woodhead Publishing Ltd.: Cambridge, UK, 1999. Recent Advances in Animal Nutrition. Nottingham University Press, Nottingham, UK.
- Terevinto, A.; Ramos, A.; Castroman, G.; Cabrera, M.C.; Saadoun, A. Oxidative status, In Vitro iron-induced lipid oxidation and superoxide dismutase, catalase and glutathione peroxidase activities in rhea meat. *Meat Sci.* **2010**, *84*, 706–710. [CrossRef]
- Ürkek, B.; Sengül, M.; Akgül, H.İ.; Kotan, T.E. Antioxidant activity, physiochemical and sensory blackberry extract. *Food Chemistry*, **101**, 1052–1058.
- Fraternale D, Giamperi L, Bucchini A, Sestili P, Paolillo M, Ricci D. *Prunus spinosa* fresh fruit juice: antioxidant activity in cell-free and cellular systems. *Nat Prod Commun.* 2009 Dec;4(12):1665–70. PMID: 20120103.
- Natić, M.; Pavlović, A.; Bosco, F.L.; Stanisavljević, N.; Zagorac, D.D.; Akšić, M.F.; Papetti, A. Nutraceuical [CrossRef] properties and phytochemical characterization of wild Serbian fruits. *Eur. Food Res. Technol.* **2019**, *245*, 469–478. [CrossRef]
- characteristics of ice cream incorporated with sloe berry (*Prunus spinosa* L.). *Int. J. Food Eng.* **2019**, *15*. [CrossRef]
- Zafra-Stone S, Yasmin T, Bagchi M, Chatterjee A, Vinson JA, Bagchi D. (2007) Berry anthocyanins as novel antioxidants in human health and disease prevention. *Molecular Nutrition and Food Research*, **51**, 675–683.
- Varga, E.; Domokos, E.; Fogarasi, E.; Stefanescu, R.; Fülöp, I.; Croitoru, M.D.; Laczkó-Zöld, E. Polyphenolic compounds analysis and antioxidant activity in fruits of *Prunus spinosa* L. *Acta Pharm. Hung.* **2017**, *87*, 1–7.
- Arzu Kavaz Yuksel, A. Kavaz Yuksel. (0000). The Effects of Blackthorn (*Prunus Spinosa* L.) Addition on Certain Quality Characteristics of Ice Cream. *Journal of food quality*, *38*, 413–421. doi: [10.1111/jfq.12170](https://doi.org/10.1111/jfq.12170)