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Integration of a vegetable protein by-product in the bakery-pastry technology

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Abstract

The qualitative and quantitative demand for food implies either increasing the bioavailability of the protein or improving its functional properties. Accessing the ***operations of physical separation*** of the natural vegetable oils industry, makes it possible to obtain "unconventional protein wastes" with food-nutritional potential through the functional properties specific to the proteins, but also of their interactions with the other components. Scakeing from the study of technology of obtaining the oils by ***physical fractionation (cold pressing)***, the opportunity to reintegrate the cakes resulting from pumpkin seeds, into the flour obtaining circuit, and subsequently characterized physico-chemically (***proteins, 52.06 g /100g product; minerals, 8.74 g / 100g product, lipids, 19.41 g / 100g product, total carbohydrates 17.99 g / 100g product, nutritional value, 454.89 kcal / 100g product***) and the possibility of their use in the bakery technology. Two directions were accessed: ***1. bread: protein, 17.66 g / 100g product; minerals, 3.56 g / 100g product, lipids, 2.94 g / 100g product, total carbohydrates 35.87 g / 100g product, nutritional value, 240.58 kcal / 100g product; 2. yeast: protein, 8.57 g / 100g product; minerals, 1.81 g / 100g product, lipids, 33.86 g / 100g product, total carbohydrates 46.58 g / 100g product, nutritional value, 525.34 kcal / 100g product***. If for the protein derivative the energy supply is conditioned by the mass of protein (***52.06 g / 100g product***), for the resulting products, it is determined by the working formula accessed. The paper also brings to mind an economic aspect of sustainable development, of ***small family businesses***, ***subsistence***, by forming associates between processors of oil-based raw materials on ***physical principles*** (***pressing, dry fractionation***) and artisan and / or professional processors in the field of food industry.

Keywords: unit operation, physical fractionation, vegetable proteins by-product, functional properties, bakery-pastry technology

1.Introduction

The studies carried out highlight the insufficient intake of proteins, dietary fiber, macronutrients through the current diet, with influences on the health status. The statement contributes to the "prospecting" of the possibility of *recovery / reintegration* in the technological circuit of baking of "unconventional" materials, rich in compounds with high biological activity (protection and maintenance factors), easy to assimilate, with a minimum energy effort from the body, which can also be directed to *personalized diets* from various conditions (gluten intolerance, diabetes, cardiovascular disease, etc.). Increasing the food intake involves either increasing the bioavailability of the protein or improving its functional properties. Accessing the *operations of the physical separation* of the natural vegetable oils industry, make it possible to obtain "*protein wastes*" with food potential through the functional properties specific to the proteins, but also of their interactions with the other components. These can contribute to the

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implementation and development of sustainable "*green entrepreneurship*" ideas.

In the face of increasingly diminished food resources, against the backdrop of a growing population, the recovery of unconventional food materials through simple technologies (in this paper the reintegration of pumpkin seed cakes into the food technology circuit) can create a sustainable economy over time.

A diverse range of agro-industrial by-products, such as cereal bran, soybean endosperm, tescovina and whey, are potential food materials with a high bioavailability (nutrients) content. For example, *whey*, a waste in the dairy industry, is characterized as a raw material in which a multitude of bioactive components are present (≈20% of total milk protein, rich in essential amino acids, functional peptides, antioxidants and immunoglobulins). This contributes to the prophylaxis of a significant range of metabolic disorders (cardiovascular, hypertension, obesity, diabetes, cancer and phenylketonuria). Whey protein complex is a good fat replacement and emulsifier, microbial protective effect. All this recommends reintegration into various food and pharmaceutical sectors [1, 2].

Pumpkin (*Cucurbita maxima*), is a plant cultivated for thousands of years, native to South America where it grows wild in ≈20 different varieties. Pumpkin seeds were discovered now ≈7000 BC. in Mexico [9].

The mature *seeds*, present in large number, oval, convex, smooth in appearance, 2 - 3 cm long, contain a white, edible core [10]. These are part of the *family of oil raw materials*. They contain selenium, magnesium, zinc, B vitamins, vitamin C, *proteins*, unsaturated and polyunsaturated fatty acids (omega-3,6,9). These contribute to the prophylaxis or treatment of some disorders of the urinary tract, anti-inflammatory processes, diuretic effect, biliary stimulant and antiparasitic. The balanced consumption of seeds contributes to maintaining the functions of the heart (pump function), in normal parameters. Magnesium contributes to the synthesis of ATP (adenosine triphosphate, the body's energy molecules), RNA / DNA, normal bone and tooth development, relaxation of blood vessels and maintaining intestinal peristalsis under normal parameters. Mineral substances reduce blood pressure and prevent myocardial infarction or stroke [11].

In Tables 1 and 2 are presented some compositional characteristics of pumpkin seeds, which condition the conduct of the unitary operations of physical processing and / or chemical processing. An important operating indicator is given by the water content (5.23g) and ash (4.78g), in the case of dried pumpkin seeds [3].

Even though the seeds have a different type-size depending on the variety, the therapeutic properties are similar (energizing, vermifuge, aphrodisiac, sedative, laxative and anti-anemic). They are high in fat (36-52%), loosible soluble vitamins (A, B, E, K), sugars, carotenoids but also contain a wide range of mineral elements, which recommend them as the father of a daily diet (table 1, 2) (*selenium*, *zinc*, *potassium* - minerals with tonic effect on bladder muscles, anti-inflammatory protection, adjuvant treatment of sexual dysfunctions or infertility). It is stated that a ½ cup of pumpkin seeds provides ≈92% of the daily requirement of Mg, and 25 g of seeds provides ≈20% of the daily dose recommended of Fe. Also the high content of *tryptophan* (essential amino acid), recommends the consumption of seeds in states of stress and insomnia. In general, the physico-chemical composition of the seeds consists of: 5% water, 30% protein, 50% polyunsaturated fatty acids, 5% carbohydrates, 10.5% starch, 4% fiber, 5% minerals [12].

Protein is a macronutrient recognized for beneficial functions on body structural development and metabolism [4, 5]. ***Amino acids***: *curcubitin* - protects the body from intestinal parasites (anthelmintic effect); *citrulline* (α-amino acid) - accelerates the reduction of ammonia-based substances, ensures the drainage of toxin tissues (it is a "*key*" intermediate in the urea cycle (the way to eliminate ammonia by converting it into urea) [8].

"*Cold*" processing of pumpkin seeds, from the technology of obtaining the raw pressed oil, results as a ***by-product of the process***, the *oil-press cake*. Technologically, it is defined as a residue that appears after liquid / solid decantation, characterized by low caloric content, high concentrations of β-carotene (vitamin A precursor) and antioxidant properties [13]. This fact recommended it for obtaining *flour* (***protein derivatives***), ***directed to the bakery and pastry industry***.

Studies indicate an imbalance in the ratio of protein fractions in the current human diet (sources are scarce and expensive). Another study confirms that protein deficiency is one of the main health problems, especially in developing countries [6].

The bakery products, offered in a wide assortment range, behave differently depending on the composition (type of flour, fat content, sugar, other ingredients), with influence on the storage time (from a few days to a few months), characteristics that influence consumer behavior [7]. Thus, bakery products are one of the major causes of food waste generation, especially when freshly distributed. This approach to a problem of *food safety* provides valuable information on ***functional foods fortified with protein complexes***.

2.2. Materials and methods

Materials: pumpkin seeds (protein derivative), wheat flour, water, salt, sugar, pork lard.

Equipment: hammer mill; sieve screen.

Methods: scakeing from the bibliographic study, with a background in the technology of obtaining the oils by ***physical fractionation (cold pressing)***, the opportunity to reintegrate the cakes (press-cake) from the resulting pumpkin seeds was discovered, by obtaining flour, subsequently characterized physico-chemically and the possibility of usage in the bakery technology (knowing that the use of the resulting cakes goes to the zootechnical sector). This led to the elaboration of an operation block scheme (Figure 1).

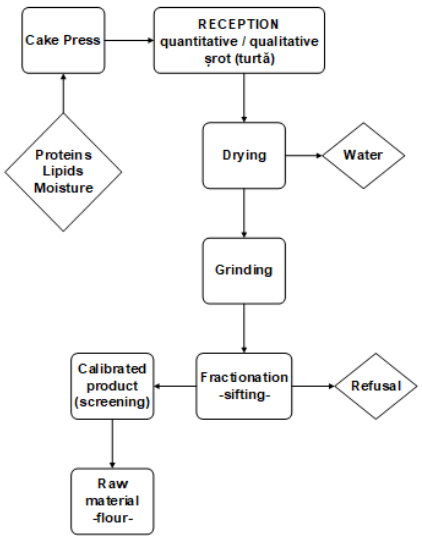

Figure 1. Flow of operations in obtaining flour from pumpkin seed cakes.

Obtained results: Flour resulting from *pumpkin seed cakes*, is a ***100% natural product***, without the intervention of additives or preservatives, with a residual lipid content, after the cold pressing operation. The physical separation method allows the preservation of the nutritional properties, especially the bioavailability of proteins. The resulting flour (figure 2), has a greenish, metallic color, with the specific smell and taste of pumpkin seeds. The average nutritional values reported per 100g of product are: energy 305 kcal, total fat 14g [14].

The resulting flour is rich in protein, insoluble fiber and omega-3 and omega-6 oils, which recommends it as an alternative (***protein derivative***), when obtaining bakery and pastry products. This recommendation is also supported by the high nutritional qualities (protein / fiber ratio), to which is added the low amount of total carbohydrates and lipids, with positive effects on body weight. The ingested proteins induce a long-term feeling of satiety, and insoluble fibers improve intestinal peristalsis, due to the fact that the fibers are not transformed into carbohydrates, so the *glycemic index stays within normal limits*, so it is recommended as part of the *diet of people with diabetes*.

Protein derivative, rich in vitamins and minerals, through the absence of gluten is recommended as a good product for people with gluten intolerance or people who maintain a vegetarian diet. The application of the physical processing methods allows the unaltered maintenance of vitamin E structure, with antioxidant role and in the prevention of cardiovascular diseases, contributing to the good functioning of the brain and neutralizing the free radicals [14]. Being an important source of minerals for the proper development and functioning of the body (Table 3), it is recommended in the diet of pregnant women and during the period of child growth (strong anthelmintic) [15, 16].

Scakeing from the literature study, in order to reach the objective - stated in the topic of the paper - the following steps have been completed:

1. obtaining the protein derivative, resulting from the pumpkin seed cakes, as a result of the cold pressing and the separation of the raw, natural, solid oil, for which "*green*" processing process was chosen, the separation by pressing (operating parameters: force press, speed and time);

2. the detection of an appropriate formulation for mixing, with white wheat flour, to which the other ingredients are added, for the ***artisanal*** production of a bakery product (bread) and pastry (cookies);
3. comparative physical-chemical and sensory quality analysis.

Following the preliminary working stages, in order to determine the proportions of the raw materials and the ingredients (their nature, in particular the materials that confer fragility (margarine, animal fat)), the manufacturing recipes (working scheme) have been identified in order to obtain ***bread*** and ***cookies***.

Table 4 presents the manufacturing recipes for bread and cookies, in which the protein derivative (pumpkin flour partially degreased by cold pressing) was integrated, as a result of successive tests.

Parametrii de operare/mod de lucru:**1.** *fursecuri* (figura 2): timp de coacere, 15-20 min.; temperatura de coacere, 180°C. Mod de lucru: într-un vas se amestecă *300g* făină albă *cu100g derivat proteic*, după care adăugăm 3 ouă întregi, 200g untură de porc, 100g zahăr şi 5g de scorţişoară. Componentele se amestcă până laobţinerea unei compoziţii omogene, după care semodelează pentru o masă de≈15g. Se așeazăîntr-o tava uscată, se introduc în cuptorul încălzi în prealabil la temepratura de180°C, cu timp de menținerede 10-15 min; **2.** *pâine* (figura 3): timp de coacere: 60 min.;temperatura de coacere,180°C. Mod de lucru: într-un vas de capacitate adecvată se amestecă ***500*** g de făină albă cu ***250*** g *derivat proteic*, după care se adaugă 500 mL lapte, 5 g sare și 10 g drojdie. Materialel se frământă manual până compoziția devine un amestec omogen. Amestecul se așează într-o tavă paralelipipedică, lubrefiată în prealabil și lăsat la dospit timp de 30 de min. după trecerea timpului de dospire, se introduce tava în cuptorul încins în prealabil la 180°C timp de 60 min.

Operating parameters / working mode: **1**. Cookies (Figure 2): baking time, 15-20 minutes; baking temperature, 180 ° C. Method: In a bowl mix 300g white flour with 100g protein derivative, then add 3 whole eggs, 200g pork lard, 100g sugar and 5g cinnamon. The components are mixed until a homogeneous composition is obtained, after which it is shaped in a mass of ≈15g. Place in a dry tray, place in the oven before heating to the temprature of 180 °C, with a holding time of 10-15 min; **2**. bread (Figure 3): baking time: 60 minutes; baking temperature, 180 °C. Method: In a bowl of appropriate capacity, mix 500 g of white flour with 250 g of protein derivative, then add 500 mL of milk, 5 g of salt and 10 g of yeast. The materials are manually kneaded until the composition becomes a homogeneous mixture. The mixture is placed in a parallelepiped tray, previously lubricated and left to stand for 30 minutes. After the waiting time has elapsed, the tray is placed in the preheated oven at 180 °C for 60 minutes.

Figure 2. Cookies made from wheat flour and protein derivative (pumpkin cakes flour).

Figura 3. Bread with the addition of flour from pumpkin cakes.

Sensory analysis of the bread and cookie samples was performed using the *scoring method* (each characteristic is described and appreciated with a number of 3 or 4 points, differentiated according to the importance of the respective characteristic, in the overall organoleptic evaluation of the product). The maximum score awarded is 20 points (Table 5). Depending on the score awarded, the product is classified as: very good, good, satisfactory and unsatisfactory.

The survey was carried out on a sample of 15 people who examined organoleptically each sample (external appearance, interior, consistency and behavior at chewing, odor, taste, color), according to the sensory files elaborated separately for sweets and bread, the table 3 and 4, and the results were entered in table 5 and 6.

For the product to be suitable, it must meet certain conditions:

- all products with a score of at least 14 points are considered appropriate;
- each characteristic evaluated to meet a minimum number of points from the maximum score established;
- for bakery assortments, the minimum allowed score is: 1 point for shape, appearance; 1.5 points for consistency, smell; 2 points for taste;
- foreign smell and taste (of mold, rancid or other foreign smells) eliminates the product from consumption.

The data obtained from the *sensory evaluation* of the cookies (table 6), shows that the product has accumulated a score of ***19.32*** points, which ranks it as ***very good***.

The data obtained from the sensory evaluation (table 7), shows that the bread sample has accumulated a score of ***18.95*** points, one that ranks it as ***good***.

Class difference between the two products: ***cookies = very good; bread = good***, appeared because of different ingredients used for the two products (table 4).

Next, physico-chemical determinations were performed (Table 8), for the determination of the nutritional and energetic value for the two products (cookies, bread) and also the characterization of the protein derivative (flour from pumpkin seed cakes) for a better comparative evaluation of the sensory analysis.

The following partial conclusions are drawn from Table 8:

1. the contribution of mineral substances of the protein derivative is recognized; the reduced values from the other samples is given by the protein / flour derivative ratio;
2. a good ***protein / lipid ratio*** (***56.06 / 19.41 g / 100g product***) is observed, in the case of the protein derivative, which recommends it as a raw material in the bakery industry and not only; these increase / decrease as a ratio of raw material / ingredients, specific to the manufacturing recipe;
3. If we look at energy value, we can see a relatively high value for the *protein derivative* (***454.89 kcal / 100g product***), a contribution brought in particular by the ***weighting of proteins***, fact recommended in various diets as well as in the diet of diabetes, except for the juices where nature and the character of the ingredients (pork lard, sugar), bring a substantial energy supply from sources other than protein.

Table 1. The composition and main characteristics of pumpkin seeds.

Source	Hectolitic weight (kg/hl)	Shell content (%)	Chemical composition (%)					
			oil	protein	[1] NES	cellulose	ash	humidity
Dovleacul	50-55	24	35-54	28-30	15-20	13-20	4-5	9-11

[1] NES - Non-nitrogenous Extractive Substances

Table 2. Values for some characteristics of dried pumpkin seeds.

Carbohydrates	Weight (g)	Minerals	Weight (mg)	Vitamins	Weight (mg)
carbohydrates (total)	10.71	Ca	46	ascorbic acid	1.9
dietary fiber	6	Fe	8.82	thiamine	0.273
total carbohydrate	1.4	Mg	592	riboflavin	0.153
sucrose	1.13	P	1233	niacin	4.987
dextrose	0.13	K	809	pantothenic acid	0.75
fructose	0.15	Na	7	B-6	0.143
starch	1.47	Zn	7.81	folate	58 (µg)
starch	1.47	Cu	1.343	choline	63
		Mn	4.543	A	16 (IU)
				carotene	10
				lutein + zeaxanthin	74 (µg)
				E	2.18
				tocopherol γ	35.1
				K	7.3 (µg)

Table 3. Nutrition information.

Average values / 100 g	
Energetic value	384 kcal/1574 kJ
Fats (g)	12
from which: saturated fatty acids	2
Carbohydrates (g)	15
from which: sugars	1.5
Protein	54
Salt	<0.01
Fibers	6

Table 4. Manufacturing recipe for artisanal bread and cookies with added pumpkin seed flour.

Cookie		Bread	
main / auxiliary	**weight (g)**	**main / auxiliary**	**weight (g)**
White flour	300	White flour	500
protein derivative	100	protein derivative	250
eggs	3	yeast	10
*pork lard	200	salt	5
sugar	100	milk	500
cinnamon	5		

* produced in their own household

Table 5. Evaluation of the organoleptic quality of the products according to the score scale.

Crt No.	Total number of points	Qualification granted
1	19,0-20,0	Very good
2	16,0-18,9	Good
3	14,0-15,9	Satisfactory
4	under 14	Unsatisfactory

Table 6. Sensory analysis of evolution as arithmetic mean values and the maximum score for cookies

Sensory indicators	Average score	Quality class
exterior shape and appearance	3,9	
interior appearance	2,93	
consistency and behavior in chewing	2,9	
smell	2,93	**Very good**
taste	3,73	
colour	2,93	
Maximum score	**19,32**	

Table 7. Values for the sensory analysis as arithmetic mean and the maximum score for bread.

Sensory indicators	Average score	Quality class
exterior shape and appearance	3,46	
interior appearance	2,93	
consistency and behavior in chewing	2,9	
smell	3	**good**
taste	3,73	
colour	2,93	
Maximum score	**18.95**	

Table 8. Physico-chemical characterization for the protein derivative and products obtained.

Sample	Humidity g/100 g product	Mineral substances g/100 g product	Protein g/100 g product	Lipids g/100 g produs	NaCl g/100 g produs	Carbohydrates g/100 g product		Energetic valuekcal/100 g product
	Method					Total from calculation	Of which sugars	From the calculation
	SR ISO 1442:2010	SR ISO 936:2009 ver.eng.	SR ISO 937:2007	*Total* SR ISO 1443:2008	SR ISO 1841-2:2000		SR ISO 91-2007	
1	1,57	8,74	52,06	19,41	0,23	17,99	4,43	454,89
2	39,73	3,56	17,66	2,94	0,24	35,87	7,75	240,58
3	8,94	1,81	8,57	33,86	0,24	46,58	22,5	525,34

1. protein derivative from pumpkin seeds; **2.** bread; **3.** cookies.

4.Conclusions

Scakeing from a simple idea, given the variety of protein derivatives currently available, access to information, cultural, economic and social disposition, all condition the trends in the field of accessing new materials with nutritional potential as derivatives / by-products of "*green*" technologies for processing, in order to obtain products closer to the needs of the body.

The paper also brings to mind an economic aspect of sustainable development, of small family businesses, subsistence, by forming associates between processors of oil-based raw materials on physical principles (pressing, dry fractionation) and artisan and / or professional processors in the field of food industry, but also from the emerging ones (food supplements, pharmaceuticals).

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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