ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Study of The Quality and Nutritional Value of the Powder of Pumpkin Seeds.

Marina Vladimirovna Mikhaylenko*, Natalia AleksandrovnaTarasenko, Irina Borisovna Krasina, and Yulia Nikolaevna Nikonovich

FGBOU VO "Kuban State Technological University" Russia, 350072, Krasnodar, Moskovskaya Street 2.

ABSTRACT

As the object of a study, which allows increasing preventive properties of foods, was used a powder of pumpkin seeds. In the investigation it was studied the amino acid and fatty acid composition of the powder of pumpkin seeds, which has a high biological and energy value. The mass fraction of protein in pumpkin seeds is not inferior to the traditional protein supplements of a plant origin. The protein content on average is more than 30 percent, in seeds of Gymnospermous pumpkin the contents reaches of 35.3. Pumpkin seeds have a high biological value. They are a source of pumpkin oil, containing in its structure a large amount of unsaturated fatty acids. Theoretically and experimentally was proved the feasibility and efficiency of use of the powder of seeds of Gymnospermous pumpkin as raw materials for the physiologically functional additives. It is shown that it has high consumer properties, a nutritional value and a physiological activity.

Keywords: pumpkin seed, chemical composition, biological value.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

For the present day the nutrition of the population is an important issue affecting the social and public spheres of life.

Nutrients from food provide the human body of a plastic material and energy, determine its health, physical and creative activity, life expectancy, its ability to reproduce. Across the country the nutritional status and dietary patterns are among the main factors that are determining the level of development and life expectancy of its citizens [6].

In the Russian Federation there is the state program that is aimed at the preserving of health and longevity of life by ensuring the needs of the human body for energy and nutrients. Were approved the legislative solutions ensuring the implementation of the Concept in the field of nutrition, food and health [1,2].

One of the promising directions of solving this problem is food consumption, contributing to the improvement in immunity and maintenance of a normal microecological climate in the human body, in another words, possessing bio-correlative properties. The use of such products in a daily diet inhibits undesirable processes and helps to improve one's health [3].

The changing of lifestyles of the population and decline or, conversely, the raising of the standards of living is associated with the increasing consumption of food, inadequate intake of vitamins and minerals along with the separate use of food and biologically active substances, led to the need of creating of preventive food products [4].

The basic method in creating products of the preventive orientation is the search and adding into the production of non-traditional herbal supplements, having a technological and physiological functionality [5].

Each herbal supplement is characterized by the individual properties that have a therapeutic and preventive effect against some diseases [6].

Functional and preventive nutrition enhances the antitoxic function of individual organs and systems of the body – liver, lungs, skin, kidneys, etc. Helps to improve the condition of the stratum corneum of the skin and the sebaceous and sweat glands, decreasing the permeability of the skin, mucous membranes of the upper respiratory tract and the gastrointestinal tract (GIT). Decreases the activity of putrefactive microflora of intestinum and increases the activity of the normal microflora, normalizes intestinal peristalsis, reduces the absorption of sitotoxins and the other xenobiotics from the gastrointestinal tract. Functional nutrition has a beneficial effect on the autoregulatory response of the body, especially on the nervous and endocrine regulation of the immune system, metabolism, and also contributes to the increasing of the overall resistance of the organism and its adaptation reserves [7].

In the solution of a problem of creation of food products with the preventive properties, it is advisable to focus on products of mass consumption.

The most promising group of products that is recommended for enrichment, – the confectionery products, which are the leading segment in the market of the Russian Federation. Flour confectionery is characterized by an imbalance of a chemical composition and a low nutritional value. They differ on the one hand by the lower content of protein, dietary fiber, very low content of micronutrients, on the other hand – by a high content of fats and carbohydrates, provides high caloric content of the product [8].

METHODS

Mass fraction of protein was determined using the system of a quantitative identification of N2/protein DKL8, the manufacturer VELP SCIENTIFICA, Italy. The biological value of powder of seeds of sainfoin was studied by an experimental determination of amino acid composition with the use of system of capillary electrophoresis "CAPEL-105M", the manufacturer, Lumex, Russia [9].

Mass fraction of dietary fiber was determined on the device for analysis of fibre FIBRETHERM FT12, the manufacturer - Gerhardt, Germany in accordance with a state standard - GOST 10846-91. Mass fraction of

fat was determined by the automatic device for a solid-liquid extraction SOXTHERM SOX414a, the manufacturer - Gerhardt, Germany [10].

Determination of the mass fraction of carbohydrates, including mono - and disaccharides, was carried out by chromatographic method on the liquid chromatograph of a high pressure in a mixture of acetonitrile – water (77:23). Quantificational determination of diterpenoid glycosides was performed on the densitometer (of a German production), estimated by a color intensity of the spots.

Mass fraction of macro - and microelements (potassium, sodium, calcium, magnesium, iron, manganese, chromium, zinc and copper) in dry leaves of stevia and skim aromatic raw materials was determined by atomic absorption spectrophotometry (AAS) on the analyzer AA-1 (Zeiss company, Germany).

Evaluation of the results of experiments was conducted with the use of modern methods of calculation of static reliability using the programs Statistica 6.0, Microsoft Office Excel 2007 and Mathcad.

All studies were carried out on the equipment of the shared research center "Research center of food and chemical technologies" of FSBEI HPE "Kuban state technological University".

The aim of our study was to study functional and technological characteristics of by-products of pumpkin processing, first of all, a powder of Gymnospermous pumpkin seeds.

RESULTS

To achieve this goal it was necessary to investigate the chemical composition of the powder of pumpkin seeds. Was analyzed a chemical composition of wheat flour of the highest grade and the pumpkin powder that was made from the pumpkin seeds, a source of unsaturated fatty acids, easily digestible vegetable protein, mineral elements and vitamins.

The mass fraction of protein in pumpkin seeds is not inferior to the traditional protein supplements of a plant origin. The protein content on average is more than 30 %, in Gymnospermous pumpkin seeds the content of protein reaches up to 35.3 %.

Table 1 presents the fractional composition of proteins of Gymnospermous pumpkin seeds.

Table 1 – Fractional composition of proteins of Gymnospermous pumpkin seeds powder.

Fractions	Mass share of fractions of proteins, %
Albumins	27,2
Globulins	48,3
Glutelins	19,9
Insoluble proteins	4,6

Proteins of pumpkin seeds contain a high mass fraction of water - and salt-soluble fractions. The predominant protein fraction of the powder of Gymnospermous pumpkin seeds are the salt-soluble proteins, their content is 48.3 %.

The main protein of pumpkin seeds is cucurbitina, which contains a number of replaceable and irreplaceable amino acids: tryptophan, tyrosine, and others [11].

Amino acid composition is an important characteristic of raw material not only for the assessment of biological value of proteins but also for their functional and technological properties.

To assess the quality of raw materials, we compared the amino acid composition of wheat flour and a powder of Gymnospermous pumpkin seeds. The data presented in table 2.

ISSN: 0975-8585

Table 2 - Amino acid composition of proteins of wheat flour [12] and a powder of Gymnospermous pumpkin seeds [13]

Amino acids	Content in g per 100 g of protein		
	The standard of FAO/WHO	Flour	Powder of pumpkin seeds
Essential amino acids			
Valine	5,0	4,77	4,86
Isoleucine	4,0	3,48	3,65
Leucine	7,0	4,76	7,86
Lysine	5,5	2,29	5,93
Methionine+cystine	3,5	3,87	2,67
Threonine	4,0	2,82	7,45
Phenylalanine	6,0	5,48	6,67
Tryptophan	1,0	1,26	0,79
The amount of essential amino acids	36,0	28,73	39,88
Nonessential amino acid			
Alanine	-	3,27	10,86
Arginine	-	3,64	8,53
Aspartic acid	-	4,62	5,71
Histidine	-	2,23	1,51
Glycine	-	3,52	7,82
Glutamic acid	-	35,78	13,63
Proline	-	13,92	4,21
Serine	-	5,03	4,04
Tyrosine	-	2,67	3,52

Analysis of amino acid composition of the powder from pumpkin seeds (PPS) shows that the protein fractions contain a complete set of amino acids, including essential, which accounts for their high biological value [13]. The content of some essential amino acids – lysine, leucine, threonine and phenylalanine is at the level of the standard of FAO/WHO and greatly exceeds it. The limiting amino acids are: valine, isoleucin, methionine, cystine and tryptophan. In wheat flour is observed a limit in the essential amino acids, while in the PPS they are in the abundance. But the content of the sum of methionine and cystine, and tryptophan in wheat flour prevails over the content of the essential amino acids in PPS. Thus, it is possible to balance the amino acid composition of the developed product by adjusting the composition of the formulation.

The numerical values of amino acid composition does not allow objectively to estimate the biological value of PPS, therefore in addition were calculated the following indicators of a biological value: amino acid score, the index of irreplaceable amino acids (IAA), the coefficient of amino acid differences scour (CADS) and biological value (BV). The results are presented in table 3.

Table 3 – Indicators of biological value of proteins of PPS and wheat flour

Figure	PPS	Flour
Amino acid scour, %		
Valine	97,2	95,4
Isoleucine	91,25	87
Leucine	112,3	68
Lysine	118,6	41,63
Methionine+cystine	76,3	110,57
Threonine	186,25	70,5
Phenylalanine	111,17	91,3
Tryptophan	79	126
IIA	1,037	0,823
CADS , %	32,7	44,67
BV, %	67,3	55,33

The minimum amino acid score for PPS was established for the sum of methionine and cystine (76.3 per cent), and for wheat flour - for lysine (41,63 %), i.e. these amino acids are the first limiting for these

products. The coefficient of amino acid differences scour (CADS), which characterizes an excessive amount of essential amino acids that is not used for plastic needs. The minimum percentage of excess scour was established for PPS.

As it can be seen from table 3 the PPS is rich with threonine. Threonine is essential for maintaining the normal protein balance in the body. This amino acid improves liver function, strengthens the immune system and is involved in the formation of antibodies. It is also necessary for maintaining cardiovascular and nervous systems. Threonine is actively involved in the biosynthesis of the amino acids glycine and serine; an important component of collagen.

In addition, threonine is greatly fights with a fatty liver, makes a positive effect on the gastrointestinal tract. Threonine actively cope with depression, helps with intolerance to certain substances such as gluten of wheat.

In particular, leucine enhances the repair (restoration) of bones and skin, it contributes to the normalization of carbohydrate metabolism (alanine). Lysine promotes the absorption of calcium by the cells. Phenylalanine improves performance, improves one`s mood, improves a memory.

Thus, the PPS in comparison with wheat flour is more balanced with amino acid composition and has a higher biological value (BV) that enables the use of the powder of pumpkin seeds as a component of a preventive nutrition.

Pumpkin seeds have a high biological value. They are a source of pumpkin oil containing in its structure a large amount of unsaturated fatty acids [11].

In determining the nutritional and biological value of raw materials is of a great importance the analysis of fatty acid composition; it is particularly important the content of polyunsaturated fatty acids (Pufas) [13]. Fatty acid composition of the powder from the seeds of the pumpkin varieties of Gymnosperms is presented in the table 4.

Table 4 – Fatty acid composition of the powder from the seeds of the pumpkin varieties of Gymnosperms

Fatty acids	Mass fraction, %, to the total amount
Palmitic acid ($C_{16:0}$)	11,31
Stearic acid ($C_{18:0}$)	6,06
Arachidic acid ($C_{20:0}$)	0,44
Oleic acid ($C_{18:1}$)	41,46
Linoleic acid ($C_{18:2}$)	40,49
Linolenic acid ($C_{18:3}$)	0,24

Fatty acid composition of the lipids of the powder of pumpkin seeds are presented mainly with the following acids: palmitic, stearic, oleic and linoleic acids. The latter together constitute for almost 82% of the total fatty acids. In small quantities are presented the arachidic and linolenic acids - 0.44 % and 0.24 %, respectively.

The most useful are the unsaturated fatty acids, which take an active part in the synthesis of biologically active substances – eicosanoids, which are precursors of prostaglandins and leukotrienes, which in turn inhibit the development of atherosclerosis, have a cardioprotective and an antiarrhythmic effect, regulate inflammatory processes in the body, lower cholesterol, etc. These substances protect the body from cardiovascular diseases, the main killer of a modern man.

It was found that the most effective impact on the human body have the unsaturated fatty acids with double bonds, which lie between the third and fourth, and the sixth and seventh carbon atoms. These acids belong to the families of omega-3 and omega-6 (ω-3 and ω-6) [14].

Polyunsaturated fatty acids – linoleic (ω-6) and linolenic (ω-3) are not synthesized in the body. They are the essential food components [13]. Powder from the seeds of the pumpkin varieties of Gymnosperms

contains 40,49 % of linoleic acid from the total amount of fatty acids. This fact is characterized by a high biological activity of lipids in the studied PPS.

The most valuable fatty monounsaturated fatty acid is oleic acid. Its content in Gymnospermous pumpkin seeds reaches of 41.46 %. It is involved in the construction of biological membranes of a person. The replacement of the monounsaturated acids dramatically changes biological property of membranes - their permeability. Fats containing this acid have the highest digestibility [11].

In addition to the significant content of proteins and fatty acids, powder of Gymnospermous pumpkin seeds is rich in carbohydrates. The content of carbohydrates in the PPS is listed in table 5.

Table 5 – Content of carbohydrate in the powder of pumpkin seeds

Figure	Content, %
Carbohydrates, including	21,39
Fiber	4,22
Soluble sugar	17,17

As it can be seen from table 5, the cellulose contents in the PPS is small (4,22 %), because of the lack of a shell of seeds. However, at the same time a content of soluble carbohydrates is fairly high.

Cellulose is a representative dietary fiber. Dietary fibers belong to the nutritious substances, like water and mineral salts, and do not provide the body with energy, but play a huge role in life.

Dietary fiber is not digested by the endogenous enzymes of the human digestive tract and is subjected to a bacterial fermentation in the colon. Dietary fiber in food products usually combined with the other food nutrients. Dietary fiber slows the digestion of carbohydrates, proteins and fats, which is important [15].

Dietary fiber is able to bind and retain moisture. Water binding capacity is an important indicator of the quality of dietary fiber. The high hydrophilicity of the fibers will influence the rheology of the semi-finished products and the quality of the finished products and will also play a role, increasing the intestinal motility and reducing a transit time in the gastrointestinal tract [16].

The low content of dietary fiber was one of the fundamental criteria for the selection of the powder from the seeds of the pumpkin varieties of Gymnosperms, as the high fiber content leads to an increase in viscosity of waffle mix, which negatively affects the technological process.

To assess the impact of dietary fiber on the dough it is important to examine the hydrophilic properties of the fibers. Components of dietary fiber are practically insoluble in water, but swell well in it. The ability of dietary fiber to bind water plays an important role in the formation of the structure of the dough.

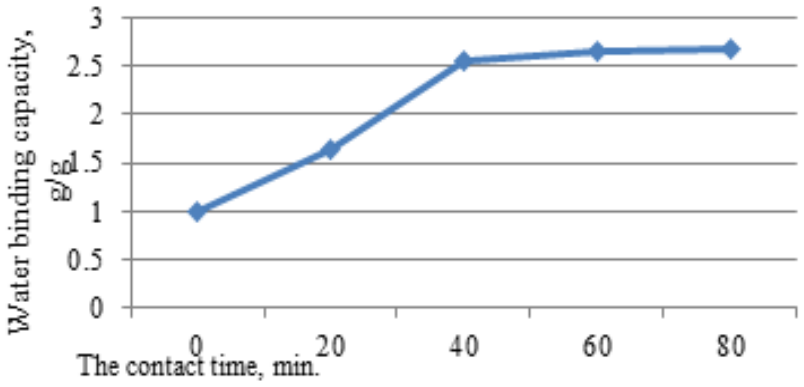

Figure 1 – Dependence of the water-binding capacity due to the contact duration

ISSN: 0975-8585

Between the dietary fiber and the protein flour is a competition for water and it results in the unsatisfactory swelling of proteins because of the lack of water, the dough becomes more solid in its consistency [17].

We have identified the dependence of the water-binding capacity of the PPS depending on duration of a contact with the solvent, and depending on the temperature of the solvent. Dependences are shown in figures 1 and 2.

The figure shows that with the increasing of a contact time of the PPS with the solvent up to 40 min, the dietary fiber almost reaches the maximum of a water-holding capacity.

Dietary fibers in the PPS have a medium water binding capacity that does not entail strong changes of rheological properties of the semi-finished product.

Figure 4.2 presents the effect of water temperature on a water binding capacity of dietary fibers. The figure shows that with the increasing of a temperature for more than 60 ℃, it increases the ability to bind moisture, and in temperature range from 20 to 60 ℃ water absorption practically does not change.

The increase in water-binding capacity with the increasing of temperature is due to the increasing activity of the functional groups of the macromolecular ions and the increase in the thickness of the solvation layer [17].

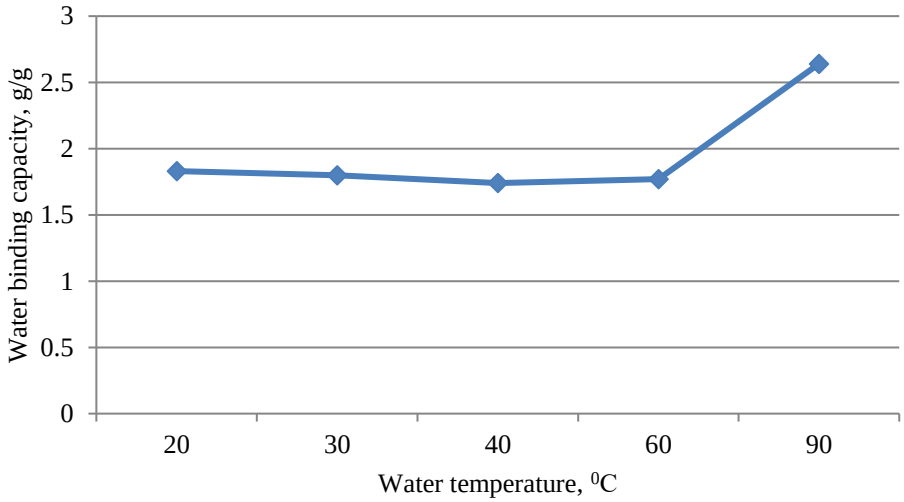

Figure 2 – Dependence of the water-binding capacity due to the water temperature

Pumpkin seeds are a valuable and promising source of a whole complex of biologically active substances: vitamins, tocopherol and minerals.

Characterization of the mineral composition of the powder of pumpkin seeds are presented in table 6.

Table 6 – Mineral composition of the powder of pumpkin seeds [13]

Indicator	Content
Macroelements, mg/100 g:	
	380,48
magnesium calcium	507,64
potassium	924,15
phosphorus	2292,15
sodium	16,03
Trace elements, mcg/100 g:	
copper	1460
iron	8220

manganese	3740
zinc	8330
Vitamins, mg/100 g of product	
Pyrodixine (B_6)	0,78
Riboflavin (B_2)	0,36
Thiamine (B_1)	0,24
α- tocopherol	29,88
β- carotene	4,49

DISCUSSION

The role of trace elements from food, is that they are a part of the vital enzymes or their activators. Among the micronutrients in the pumpkin seeds was detected a significant amount of zinc and iron. It should be emphasized the importance of the presence in the seeds of pumpkin a significant amount of zinc. The biological role of zinc is determined by its necessity for normal growth, development and puberty and maintaining of reproductive function and the proper functioning of the immune system, normal blood formation, taste and smell, stimulating the healing and repair of wounds [13].

The seeds of pumpkin fruits are considered of a high content of vitamin E – tocopherol (29,88 mg/100 g wet matter). Its biological role is that it is a biocatalyst and is one of the powerful antioxidants, protecting against oxidation of polyunsaturated fatty acids, retinol and carotenoids [11].

Draws attention to the high magnesium content (507,64 mg/100 g), which is involved in bone formation, regulation of the nervous tissue, carbohydrate and energy metabolism. This macroelement improves blood flow to the heart muscle, functions as a cofactor with a high power in more than 300 enzymatic reactions.

Also the mineral composition of the powder from pumpkin seeds has a high content of phosphorus, which is a part of the coenzymes, cell membranes, and is involved in the metabolism of proteins, fats and carbohydrates, participates in the formation of bones and also regulates the nervous system [14].

CONCLUSION

It was proved both theoretically and experimentally the feasibility and efficacy of the use of the powder of Gymnospermous pumpkin seeds as raw materials for physiologically functional biologically active additives (BAA). It was shown that it has a high consumer properties and nutritional value and physiological activity.

AKNOWLEDGMENTS

The work was performed under the grant of the President of the Russian Federation for the state support of young Russian scientists – candidates of Sciences (MK-4970.2016.11) on “Biochemical study of the microstructure of vegetable fiber to create preventive confectionery products with use of modern methods of nutrimemetabolics”.

REFERENCES

[1] Tutelian V. A., Sukhanov B. P., Kerimova M. G. The background and factors of formation of regional policy of healthy nutrition in Russia // Issues of nutrition. 2007. # 6. P. 39-43.

[2] Tutelian V. A., Knyazev V. A. Realization of the concept of state policy of healthy nutrition of the population of Russia: best security // Issues of nutrition. 2003. # 3. P. 4-7.

[3] Panina O. R., Sadovoy V. V., Myakinnikova E. I. Formulation of products of antidiabetic orientation // Modern problems of quality and food safety in the light of the requirements of technical regulations of the customs Union: collection of materials of international scientific-practical Internet-conference, March 26, 2014 Krasnodar: publ. KubSTU, 2014. P.28-30.

[4] Boltenko , Y. A., Rodicheva N. V. Rheology of vegetable powders [electronic resource] // Scientific results. Series "Technology, business and service". 2015. Volume 1. # 1. 39-44. Mode of access: http://rr.bsu.edu.ru/images/issue3/business/business.pdf. Date of access: 24.05.2016.

[5] Tarasenko N. A. Bolgova D. Yu., Ershova N. P. Development of wafer products using a powder from tubers of Jerusalem artichoke // Bulletin of Universities. Food technology. # 2-3, 2016, P. 49-51.

[6] Kayazkaya A. S., Berdina A. N.. Enrichment of granulated cottage cheese by amaranth flour // Food innovation and biotechnology: materials of the International scientific conference. – Kemerovo: FGBOU VPO "Kemerovo technological Institute of food industry", 2014. Volume 2. P. 63-65.

[7] Mogilniy M. P. The role of functional properties of proteins in a special kind of power // Proceedings of the universities. Food technology. 2009. # 1. Pp. 51-54.

[8] Gerasimenko, E.O., Butina, E.A., Kharchenko, S.A., Achmiz, E.P., Vorontsova, O.S. Prospects of the "green" technologies of the complex processing of sunflower seeds Research Journal of Pharmaceutical, Biological and Chemical Sciences. Volume 7, Issue 2, 2016, Pages 609-623. 2-s2.0-84962591136

[9] MR 04-38-2009 capillary electrophoresis System Drops®. Determination of proteinogenic amino acids in fodders and raw materials.

[10] Tarasenko N. A, Butina E. A, Gerasimenko E. O., 2015. Peculiarities of chemical composition of sainfoin seeds powder. ORIENTAL JOURNAL OF CHEMISTRY; 31(3). Available from: http://www.orientjchem.org/?p=10557. DOI : http://dx.doi.org/10.13005/ojc/310346

[11] Husid, S. B. Study of biologically active compounds in seeds of different pumpkin varieties [Electronic resource] / S. B. Husid [and others] // Scientific journal of the Kuban state agrarian University. – 2014. – № 96 (02). – URL: http://ej.kubagro.ru/2014/02/pdf/60.pdf (date accessed: 25.02.2016).

[12] Nechaev A. P. Food chemistry. – SPb.:GIORD, 2003. – P.640

[13] Vasilieva A. G., Kruglova I. A. Chemical composition and potential biological value of pumpkin seed of different varieties // Proceedings of the universities. Food technology. 2007. # 5-6. p.30-33.

[14] Doronin, A. F. Functional food products. Introduction to technology; ed. by A. A. Kochetkova. M: Delhi print, 2009. p.288

[15] Tarasenko, N.A., Krasina, I.B. Developing procedures and recipes of dietary wafers with stevioside // European Journal of Physical and Health Education. Volume 6, 2014, Article number BM-009-14. 2-s2.0-84907694645

[16] Krasina, I.B., Tarasenko, N.A. Research way of obtain extracts from walnut leaves, their properties investigation on purpose to use them as ingredients during jelly fruit candy production// American-Eurasian Journal of Sustainable Agriculture. Volume 8, Issue 9, 1 June 2014, Pages 23-26. 2-s2.0-84907057278

[17] Siro I., Kapolna, E., Kapolna, B., and Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance-A review. Appetite, 51: 456-467.