

## Usage of the nut raw materials and chia seeds to improve fatty acid composition of the smoothies

Andgela Dyakonova, Victoria Stepanova

Odesa National Academy of Food Technologies, Odesa, Ukraine

---

### Abstract

---

#### Keywords:

Nut  
Chia  
Fatty acid  
Drink  
Smoothies

---

#### Article history:

Received 12.10.2016  
Received in revised  
form 21.12.2016  
Accepted 27.03.2016

---

#### Corresponding author:

Victoria Stepanova  
E-mail:  
upiu@ukr.net

---

DOI: 10.24263/2304-974X-2016-5-4-10

**Introduction.** Today, the ways of using nut, seed raw materials and its combinations as a source of essential fatty acids for healthy products are not sufficiently investigated.

**Materials and methods.** We have investigated the composition of ingredients of the universal base for the beverage industry. The content of proteins, fats, carbohydrates, ash and caloric of product was determined. With the help of the gas chromatography method, fatty acid structure of the prescription components was investigated and the ratio of  $\omega$ -3 and  $\omega$ -6 fatty acids in ready-made product was found out. We studied the amino acid content of the developed composition, its viscosity and storage stability.

**Results and discussions.** The authors suggested 9 recipes of smoothies drinks with different organoleptic characteristics. The results show, that 250 cm<sup>3</sup> of the investigated drinks can satisfy daily need of the healthy person in linolenic and linoleic acids on 30 %, because their content in the prepared drinks is accordingly at least 0,5 g and 2 g. Such drinks are recommended to all groups of population, especially to people, who have a disease of cardiovascular system or wish to support its work in normal state.

Usage of chia seeds and walnuts significantly increase the content of biologically valuable substances in beverages. Chia seeds significantly affect on the rheological parameters of smoothies, increasing density and viscosity of drinks due to mucous substances of seeds' grains and also provides stability of fatty system at storage. The ability of chia seeds to create sliminess is explained by content of water-soluble polysaccharide – pentozans, which constituted to 8 % weight of grain seed. The findings suggest that the usage of chia seeds as part of a universal base maintains its stability by 100 % during 24 hours, which fully meets the needs of public catering establishments. Proteins which are a part of walnut – seed basis for smoothie drinks production have perfect composition. The limiting amino acids are lysine, methionine + cysteine, treonin and valin.

**Conclusions.** For the first time the possibility of using chia seeds as a structurant of smoothie drinks and ingredients composition for the production of universal bases for beverages, which has a balanced content of  $\omega$ -3 and  $\omega$ -6 fatty acids were studied.

---

## Introduction

The analysis of statistical researches of physicians demonstrates that for the last year thousands people died because of cardiovascular system diseases [1]. These indexes show the necessity of disease prevention of such a type. One of the aspects of cardiovascular system diseases is the healthy nutrition and the usage of products which have positive influence on cardiovascular system.

In solving the problem of a large number of human diseases is important to providing the population with products of healthy food. A creation and implantation in the structure of foodstuffs which contains physiologically valuable natural ingredients that are capable to renew the content of scarce essentially nutrients and to weaken negative technogenic influence of environment on a human body is necessary. The market of products of healthy food constantly develops, but the main part of such products in our country is replenished by foreign producers.

Usage of various technologies of processing of food raw materials is accompanied by considerable decrease of content of native foodstuffs in diet of modern people. Technological operations deprive food of the important biologically active substances which are necessary for normal functioning of human organism which leads to different diseases that are called "diseases of civilization".

That's why the creation of multicomponent products of healthy food on the basis of natural raw materials, that contains biologically and physiologically necessary ingredients for human health recovering and expansion of their range, belongs to actual problems of the present day. With the help of combination of various natural raw materials and product recipe modeling, it is possible not only to weaken the influence of external negative factors on a human constitution, but also to get a product of new generation, which will prevent from alimentary-related conditions and diseases.

**Formulation of the task.** Design of functional food fat-containing products provides for the creation of the structures balanced by optimum composition of irreplaceable fatty acids and fat-like substances that have the corresponding functional and improving properties. For the correction of food diets and optimization of fatty balance, various fatty seasonings, such as pastas and sauces are included which usually have high caloric content and are not recommended as a food for certain diseases.

The previous researches showed us the necessity of creation of products for the daily use which have the low caloric content and the balanced fat and acid structure.

Now a considerable popularity as the products of healthy food, have got smoothie drinks that are prepared from fresh fruits, vegetables and berries. Smoothies are the drinks with stiff consistence that are more like desserts. Some consumers replace with this product one meal that's why the biological value of smoothie should be high and has healthy properties.

## Analysis of scientific works

Prevention of cardiovascular system diseases demands the adequate balanced food. One of the main causes of such diseases is insufficient intake of polyunsaturated fatty acids, which are responsible for a lipid metabolism in human organism. The main sources of these substances are products with high content of fat, especially of vegetable origin.

Within the last two decades fatty products became the object of close attention of both foreign and native scientists. It is connected with the fact, that fats are included into the

main three feedstuffs with proteins and carbohydrates and contain functional ingredients – polyunsaturated fatty acids, phospholipids and fat-soluble vitamins. Non-saturated fatty acids such as  $\omega$ -3,  $\omega$ -6 and  $\omega$ -9 play an important role in maintaining the health of each person and are involved in metabolism. They influence favorably on immune, cardiovascular and nervous systems of an organism. These fatty acids are very important for the person, but they are not synthesized or synthesized in our organism in small quantities. A lot of authors singled out the so-called vitamin F, which contains essential linoleic and linolenic acids, which are the main components of  $\omega$ -6 and  $\omega$ -3 fatty acids.

The majority of the foodstuff that is widely used around the world contains  $\omega$ -3 and  $\omega$ -6 fatty acids in the unbalanced ratio. The balanced content of  $\omega$ -3 and  $\omega$ -6 fatty acids in food is required to support the balance of hormonal, cellular and other metabolic processes in organism. It is well known that for the best digestion of fatty acids such as  $\omega$ -3 to  $\omega$ -6, the ratio of 1 to 4 is necessary. Today, according to the World Health Organization in the majority of food diets of people the ratio is of 1:10 to 1:20 depending on age and eating habits of interviewed persons [2].

Despite these data, foods balanced with fatty acid composition produced in a small amount. For example, most of the healthy foods take drinks, and very popular healthy drink is smoothies. Usage of smoothie drinks grows every year, but there is not a smoothies with balanced fatty acid composition. Today smoothies are prepared and suggested almost in all public catering establishments, but the investigation of their physical and chemical indicators and their influence on human organism is not complete and it is paid not so much attention to the study of such a question.

Now the researches of European countries found that high active acidity of smoothie leads to the formation of tooth enamel erosion [3]. In Europe, the production technology of smoothie is created for gerodietetic food products, smoothie of radio protection effect on a grain basis and smoothie which is prepared on the basis of feijoa for people who have lack of iodine in organism [4, 5, 6].

**The purpose of the work** is studying of possibility to use of walnuts and chia seeds as a source of essential fatty acids in the universal basis for drinks.

## Materials and methods

### Investigated materials

Fruit, berry or vegetable raw materials are carefully crushed in a mashed state during preparing of smoothie drinks. Such mashed sauces are very dense and viscous that's why the producers adjust their consistence by the adding of water, crushed ice, juice, ice cream or milk. In addition to enrich the product with biologically valuable substances and to make the smoothie with juice spice taste, we proposed to use a liquid universal basis in the form of walnut-seed composition, which is made of vegetable milk and chia seeds.

To increase the content of polyunsaturated fatty acids particularly  $\omega$ -3 and to ensure the desirable rheological properties of the product chia seeds are used by us. 100 g of chia seeds contain more than 20 g of protein and about 35 g of fat and 38 g of carbohydrates [7]. Chia seeds are valued as natural product which have curative properties because polyunsaturated fatty acids of chia seeds are presented in 41–59 % alpha-linolenic ( $\omega$ -3) fatty acid and 18–25 % linoleic ( $\omega$ -6) fatty acid.

In this research chia seeds are chosen as the object of the research that are cultivated in Paraguay and bought in ecomarket; vegetable milk of own production which was derived

from a Walnuts kernel according the technology that was suggested by us and created smoothie drinks.

Milk from a Walnuts kernel can be prepared in two ways: the first way includes frying of the Walnut kernel, separation of the Walnut shell, soaking of the kernel in 7 fold volume of water with further soaking and careful crushing with the help of blender. A prepared mixture is sustained at the room temperature within 30 minutes and then crushed to the state of emulsion and filtered.

Preparation of vegetable milk by the second way allows using crude Walnut kernels which are presoaked in water for 6–8 hours, and then they are carefully washed out, boiled and mixed up in 7 fold volume of water and crushed. The prepared mixture is filtered and subjected to fine-dispersed grinding again. For the basics, which is recommended to be used for the smoothie drink production, vegetable milk from the Walnuts kernel is mixed up in a certain proportion with chia seeds. For this purpose chia seeds are weighted and added to the nut milk and carefully mixed up and sustained for swelling.

Depending on what technology vegetable milk was prepared, the difference in organoleptic indicators of ready drinks is observed. Milk from the roasted kernel has more expressed nutty flavor and creamy color and milk from crude nuts has white color and more neutral flavor.

It should be noted, that substitution of milk of an animal origin by vegetable nut milk significantly increases a number of consumers of the created smoothies. Vegetarians, people who are not capable to take milk proteins and lactose in, can use this product and it also can be used during a post.

We used in our research the first way of preparing vegetable milk from a Walnut kernel.

### **Description of the methods and facilities**

For the definition of physical and chemical indicators of products, standard methods described in special literature are used. Determination of viscosity of liquids was carried out by Ostwald's method [8]. The moisture, fat and ash contents were determined using standard methods [9]. Protein content was determined by Kjeldahl [10,11].

Isolation and separation of emulsion visually evaluated in a static beaker test method after a certain period of time (eg, 4 hours). Further statistical test is performed in a separatory funnel by measuring changes in concentration. In this case, change in the concentration of emulsion at the bottom of the separating funnel after a predetermined time is also determined and compared to the initial concentration of the emulsion immediately after mixing [12].

Determination of the total fat content [13]. To determine fatty acid content in the created products of gas chromatography method is used [14, 15]. Researches were conducted on the gas chromatograph Shimadzu GC chromatograph-14a with a flame ionizing detector according to the ISO 5508-2001 standard.

For receiving valid data, samples were analyzed not less than three times with the following statistical processing.

## Results and discussions

Scientists have proved, that daily intake of  $\omega$ -3 and  $\omega$ -6 fatty acids for the healthy person depending on age and body weight is accordingly an average of 1,4 and 5,6 g [16]. To give smoothie healthy effect on cardiovascular system, the content of polyunsaturated fatty acids in drinks should be raised for creating required ratio of  $\omega$ -3 and  $\omega$ -6 fatty acids, that's why these criteria were chosen as the main ones during modeling fatty basis for the production of smoothie drinks. The content of basis recipe components for the production of smoothie is given in the Table 1.

**Table 1**  
**Formulation of the basis for the production of smoothies**

Raw materials	Components content	
	Brutto, g	Netto, g
Walnut kernels	20	15
Chia seeds	1,67	1,67
Drinking water	150	150

According to the standard methods, the content of some biologically valuable substances in the created basis of smoothie drinks was determined. The research results are shown in Table 2.

**Table 2**  
**Chemical composition of bases**

Name	Content g / per serving (150 g)
Proteins	2,89 ± 0,2
Fats	5,0 ± 0,2
Carbohydrates	2,85 ± 0,1
Ash	0,63 ± 0,02
Dietary fiber	2,46 ± 0,05
Calorie, kcal	119,3

If to compare chemical composition of the developed basis with a composition of ice cream sundae or creamy ice cream [17], which is often used as a basis for production of smoothies, we can conclude, that our basis has almost 2 times less calories, contains almost identical amount of protein, but at the same time contains 8 times less carbohydrates and twice less fats and also it contains all the necessary for our organism vitamins and dietary fibers. It should be pointed out, that ice cream fats are presented by saturated fatty acids the number of which in the diet of modern person is more than the daily need in contrast with the created composition.

For substantiation of healthy properties of drinks and the appropriateness of the use of the created smoothies for the prevention of cardiovascular diseases, the research of the content of the main polyunsaturated fatty acids was made; the quantity of  $\omega$ -3,  $\omega$ -6,  $\omega$ -9 fatty acids and their ratio in the created basis for smoothie drinks is counted. Results of the research are given in Table 3.

Table 3

The content of essential fatty acids in the developed compositions

Fatty acid name	Fatty acid Lipid formula	Content in portion (150 g), g	Content in portion (150 g), %
Alpha-linolenic	18:3	0,56 ± 0,01	11,2
Linoleic	18:2	2,14 ± 0,05	42,8
Oleic	18:1	0,65 ± 0,01	13,0
∑ω-3		0,69 ± 0,01	13,9
∑ω-6		2,77 ± 0,05	55,4
∑ω-9		0,8 ± 0,01	16,0
∑ω-3: ∑ω-6			1:4

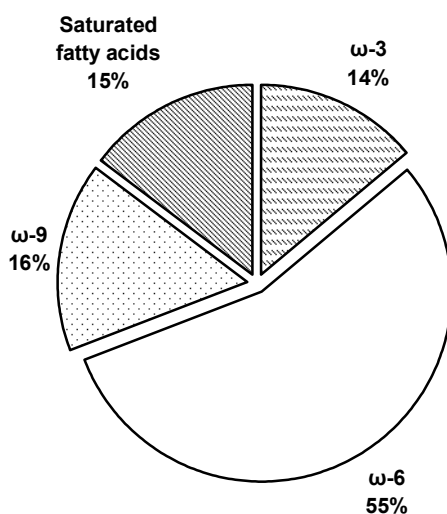
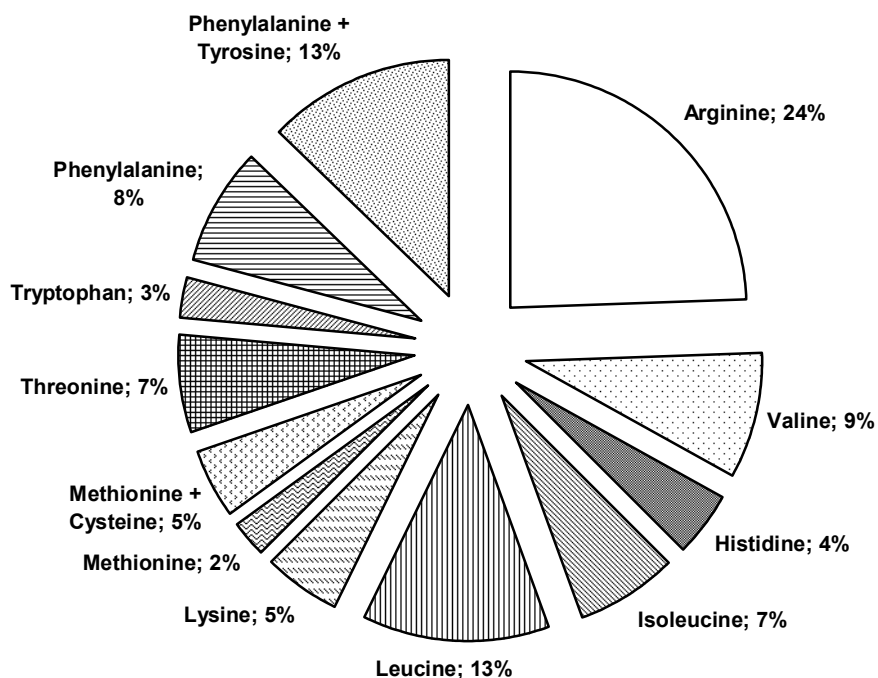


Figure 1. The content of fatty acids in the developed based

Taking into consideration the fact that walnuts and chia seeds contain a significant number of proteins the research of qualitative composition of proteins of the created composition was made and its amino-acid structure is determined. Results of research are presented in Figure 2.



**Figure 2. Amino acid composition of the nut-seeds bases for the production of the smoothies**

For determination of biological value of proteins of the created walnut and seed composition amino-acid is counted. Calculation of amino acid score is reduced to calculating the percentage of each amino acid in the test protein relative to their content in the protein as a reference, according to this formula:

$$AS = \frac{AKh}{AKc} \cdot 100\%$$

where AKc – contents of amino acids in standard protein;  
 AKh – contents of amino acids in the researched protein.  
 Proteins of chicken egg are taken for a standard.

Limiting are those essential acids, amino acid score of which is less than 100%.

From the results of the research we can make a conclusion that proteins which are a part of walnut – seed basis for smoothie drinks production have perfect composition. The limiting amino acids are lysine, methionine + cysteine, treonin and valin.

Samples of the created smoothies belong to the non-Newtonian pseudo-plastic liquids, the increasing shear rate of which influences on falling of effective viscosity. Viscosity of vegetable milk is caused mainly by its proteinaceous and mucous components. It should be

pointed out, that during the contact of chia seeds with liquid on a surface of each grain of seed the gel cover is appeared, which is characterized by high content of soft and soluble food fibers. The ability of chia seeds to create sliminess is explained by content of water-soluble polysaccharide – pentozans, which constituted to 8 % weight of grain seed. These gels significantly affect on the structural and mechanical properties of the developed smoothies, provide the necessary structure and prolong the stability of the system.

**Table 4**

**Amino-acid score of universal bases for the production of smoothies**

<b>Amino acid</b>	<b>Amino acid score, %</b>
Isoleucine	102,79
Leucine	102,32
Lysine	54,11
Methionine + Cysteine	76,37
Phenylalanine + Tyrosine	118,94
Treonine	92,34
Tryptophan	150,52
Valine	96,02

From the results of the research we can make a conclusion that proteins which are a part of walnut – seed basis for smoothie drinks production have perfect composition. The limiting amino acids are lysine, methionine + cysteine, treonin and valin.

Samples of the created smoothies belong to the non-Newtonian pseudo-plastic liquids, the increasing shear rate of which influences on falling of effective viscosity. Viscosity of vegetable milk is caused mainly by its proteinaceous and mucous components. It should be pointed out, that during the contact of chia seeds with liquid on a surface of each grain of seed the gel cover is appeared, which is characterized by high content of soft and soluble food fibers. The ability of chia seeds to create sliminess is explained by content of water-soluble polysaccharide – pentozans, which constituted to 8 % weight of grain seed. These gels significantly affect on the structural and mechanical properties of the developed smoothies, provide the necessary structure and prolong the stability of the system.

**Table 5**

**Change of rheological parameters of the bases for the production of smoothies, during storage**

<b>Indicator</b>	<b>Storage life, h</b>			
	4	8	12	24
Viscosity, Pa·s	1,497	1,530	1,535	1,550
Stability, %	100	100	100	100

To expand the range of smoothies recipes of three drinks types – berries, fruits and vegetables were developed. Recipes of the developed beverages are presented in Table 6.



Table 6

Content of formulation components in smoothies

Ingredients	Berries smoothie			Fruits smoothie			Vegetables smoothie		
	The content of components, g								
	1	2	3	4	5	6	7	8	9
Bases for the production of the smoothies	150	150	150	150	150	150	150	150	150
Blueberries	50								
Strawberries		70							
Cherry			70						
Peaches				70		70			
Apricots					70				
Frozen melon pulp						50			
Cucumbers							90	80	80
Lemon	2						10	10	
Mint								30	
Spinach							30		50
Frozen banana	50	50	50	50	50				
Optional									
Sugar	5		5	5	5	5			
or fructose	2,8		2,8	2,8	2,8	2,8			
or honey	3,3		3,3	3,3	3,3	3,3			

For justification of expediency of use of the created basis for the production of smoothie drinks we compared the content of polyunsaturated fatty acids in the created basis and in smoothie that was made without its usage, but on the basis of drinking water. Drinks that are made according to the developed recipes, but on water basis contain from 0 to 0,068 g of polyunsaturated fatty acids in the ready drink and haven't preventive effect on cardiovascular system of the person. While drinks on the basis of walnut - seed composition contain from 2,58 g of polyunsaturated in ready smoothie and satisfy daily need in these functional ingredients at least for 30%.

### Conclusion

The results of analytical and experimental researches confirms that the nut oils and fats in chia seeds, which are taken in the right proportions, providing the right balance of polyunsaturated fatty acids in universal composition which should be used as a basis for smoothie drink production. The basis is like liquid of emulsion type with impregnation of chia seeds, which has neutral taste, nutty flavor and combines well with any raw material.

Usage of this composition in smoothie drink gives an opportunity to raise the content of essential fatty acids in the product thanks to what the drinks according to the suggested basis satisfy need of healthy person in polyunsaturated fatty acids at least for 30%.

For the first time the authors scientifically substantiated the expediency of the combination of chia seeds with walnuts to obtain the necessary ratio  $\omega$ -3 and  $\omega$ -6 fatty acids. Also for the first time the universal basis for smoothie drinks production with the set content of nutrients is created. Authors proved that chia seed can be used in food products as a structurant. Usage of various prescription components confirms the universality of elaborated composition.

## References

1. Kovalenko V. N., Dolzhenko M. N., Niecukai E.G., Dyachenko Ya.S., Nudchenko A. O. (2015), The Comparative characteristic of prevention of cardiovascular diseases in Ukraine and Europe according to the research EUROASPIRE IV: hosp. line, *Ukrainian cardiological magazine*, 4, pp. 17–24.
2. Lewis E. J. H. (2015), 21 days of mammalian omega-3 fatty acid supplementation improves aspects of neuromuscular function and performance in male athletes compared to olive oil placebo, *Journal of the International Society of Sports Nutrition*, 12 (1), pp. 1–11.
3. Tahmassebi J., Kandiah P., Sukeri S. (2014), The effects of fruit smoothies on enamel erosion, *European Archives of Paediatric Dentistry*, 15(3), pp 175–181.
4. Dyakonov A.G., Toryanik A. I., Svidlo K. V., Lipovoy D.V. (2013), Project technology of gero-dietetical smoothie on basis of oat seed grit and cellulose moisture content estimation, *Scientific journal NRU ITMO Series "Processes and Food Production Equipment"*, 1, pp. 15–18.
5. Kalugina I. M., Nenova A. V. (2014), Development of technology iodinated smoothie on the basis of a feijoa, *Journal of «Research works» published by Odesa national academy of food technologies*, 46(2), pp. 129–133.
6. Peresichnyy M., Neilenko S. (2010), Smoothie technology of radio protective action, *Commodities and Markets*, 2(10), pp. 48–55.
7. Ixtaina V. Y., Nolasco S. M. (2008), Physical properties of chia (*Salvia hispanica* L.) Seeds, *Industrial Crops and Products*, 28(3), pp. 286–293.
8. Viswanath D. S., Ghosh T., Prasad D. H. L., Dutt N. V. K., Kalipatnapu Y. Rani, (2007), *Viscosity of Liquids: Theory, Estimation, Experiment and Data*, Springer, Dordchert, The Netherlands, available at: <https://books.google.com.ua/books?id=TD3TeErQDoC&pg=PA17&lpg=PA17&dq#v=onepage&q&f=false>
9. AOAC Association of Analytical Chemists (2000), *Standard Official Methods of Analysis Chemists. 17th edition*, S.W Williams (Ed), Washington D.C.
10. Magomya A.M, Kubmarawa D., Ndahi J.A, Yebpella G.G. (2014), Determination of plant proteins via the kjeldahl method and amino acid analysis: a comparative study, *International journal of scientific & technology research*, 3 (4), pp. 68–72.
11. Pillay D., Mehdi, R. (1970). Separation of amino acids by thin-layer chromatography, *Journal of Chromatography*, 47, pp. 119–123.
12. Schaafsma G. (2005), The protein digestibility corrected amino acid score (PDCAAS) – A consent for describing protein quality in foods and food ingre dients, *A critical review j AOAS International*, 88(3), pp. 988–94.

13. Jensen W. B. (2007), The Origin of the Soxhlet Extractor, *J. Chem. Education*, 84(12), pp. 1913–1914, DOI:10.1021/ed084p1913.
14. Dieffenbacher A., Pocklington W.D. (1992), *Standard Methods for the Analysis of Oils, Fats, and Derivatives. 1st supplement to the 7th edn*, Blackwell Science, Oxford.
15. Iliana Kostova, Dimitar Dimitrov, Mihaela Ivanova, Radka Vlaseva, Stanka Damyanova, Nastya Ivanova, Albena Stoyanova, Oleksii Gubenia (2014), The possibilities of using of essential oils in dairy products. 2. Dill (*Anethum Graveolens*), *Ukrainian Food Journal*, 3(4), pp. 516–523.
16. Levitsky A.P. (2002), *Ideal formula of fatty food*, Odesa biotechnology, Odesa.
17. Skurikhin I.M., Tutelyan V.A. (2002), *Chemical composition of the russian foodstuff, The reference book*.