Technology for production of purpose-fat mixtures using flax seeds

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Abstract. The article analyzes the indicators characterizing the nutritional value of dried and ground flax seeds in the production of powdery-fat mixtures for the purpose of national flour soup of the "atoli" type, traditionally used in the republics of Central Asia to feed women in the initial postpartum period. The nutritional and energy value of this product with the addition of a flaxseed component has been determined. The main attention is paid to balancing the fatty acid composition according to the ratios of fatty acids of the family ω6 and ω3, as well as saturated, mono- and polyunsaturated. It is shown that the flour component of atola dominating in the existing formulation is wheat flour of the 1st grade or wallpaper, and the fat component is mutton or cream ghee. In this regard, it is proposed to use a fat-flour composition instead of fat, the flour component of which is a crushed non-fat mass of oilseeds of flax. The use of the combination effect makes it possible to increase the nutritional value of products by significantly increasing the content of physiologically significant limiting nutrients in them.

1 Introduction

Currently, there are practically no specialized products for women's nutrition, especially in the initial postpartum period. At this stage, no special diet is required, at the same time, food should promote rapid relaxation of the body, be varied, tasty, of course, safe and preferably correspond to the national mentality. Therefore, special attention should be paid to special dishes traditionally used and tested over the centuries that are included in the diet of women after childbirth. Thus, in the republics of Central Asia, including Uzbekistan, a special dish based on a flour-fat mixture, the so-called “atola or flour soup,” is widely used.

The main ingredients of atola are wheat flour, melted lamb fat (clarified butter is allowed) and water in a ratio of 1:0.4:1.8 (2.0). The flour is sifted, mixed with hot fat and fried until golden brown. It should be noted that traditionally such a flour-fat mixture (semi-finished product) is prepared for future use and stocked with it. It can be stored in the refrigerator for quite a long time. To prepare atola (flour soup), water is gradually added to the flour-fat mixture with continuous stirring until the consistency of sour cream. The mixture is boiled

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to a humidity of 60±2%. In 5 min. before the end of cooking, you can add a raw egg and add salt.[1]

Our previous research established the feasibility of using the wheat germ product as an alternative substitute for wheat flour in the atola recipe in order to fortify its physiologically functional properties and expand the scope of application, including for the prevention of nutrition-related diseases and disorders of the normal functioning of life. important systems of the body. The possibility of replacing high-quality wheat flour with wheat germ flour and 50% animal fat with sunflower or olive oil has been established.

2 Materials and methods

These studies make promising further developments on the use of other non-traditional oilseeds, in particular flax seeds, in the production of flour-fat mixtures (hereinafter MFA).

Flax seeds and their processed products in their nutrient composition are a universal food fortifier.

The flax family (Linaceae) includes the genus Linum, which has about twenty-two species. There are known works on the use of flax seeds and flax flour in the production of bakery and flour confectionery products.

This product is characterized by a high content of protein, fat and, especially, essential fatty acid ω-3.

The purpose of the study was to develop a recipe for the preparation of flour-fat mixtures such as atola using non-defatted oil flax seeds.

The objects of the study were flour samples; flax seeds, fats and oils; flour-fat mixtures prepared according to the recipe and technological parameters at atol.

The local oilseed flax seeds “Bakhmal” were selected for research.

The results of the study are presented in Tables 1-3.

Strengthening the nutritional properties of the product is possible as a result of partial replacement of varietal wheat flour with similar, but biologically more complete mealy products from cereals and seeds of oilseeds and low-oil crops, as well as through the combinatorics of animal fat with vegetable oils [2-3].

3 Results and discussion

The dominant recipe component of atola is 1st grade wheat flour (Mpsh.) or wallpaper (Mob.).

As a recipe component of this product, we used pre-dried and ground to the coarseness of dietary flour, non-defatted oil flax seeds, hereinafter flax pulp (FL).

The chemical composition of the studied samples of flour and flaxseed raw material is presented in Table 1.

Table 1. Chemical composition of the studied raw materials.

Nutrients	Wheat flour				Flaxseed non-fat mass (LM)	
	1 grade		wallpaper			
	100 g of product	100 g SV *	100 g of product	100 g SV	100 g of product	100 g SV
Nutrients, g:						
water	12.2	-	12.0	-	6.5	-
squirrels	10.6	12.1	12.5	14.2	16.3	17.4
carbohydrates	73.2	83.4	68.2	77.5	17.4	18.6
fats	1.3	1.5	1.9	2.2	39.0	42.4
cellulose	0.2	0.2	1.9	2.2	16.2	17.3

ash	0.7	0.8	1.5	1.7	2.5	2.7
Minerals, mg:						
calcium	24	27	39	44	248	265
magnesium	44	50	94	107	372	398
phosphorus	115	131	336	382	625	648
iron	2.1	2.4	4.7	5.3	5.8	6.2
Vitamins, mg:						
thiamine, B1	0.25	0.28	0.41	0.46	1.57	1.70
riboflavin, B2	0.08	0.09	0.15	0.17	0.15	0.16
niacin, PP	2.20	2.50	5.5	6.25	2.84	3.04
tocopherols, E	3.00	3.40	-	-	18.65	19.95
Other substances, g	1.8	2.0	2.0	2,2	0.9	1.0
Energy value, kkal	328.6	-	322.8	-	492.2	-

Note: *DM – dry matter

A comparative analysis of the chemical composition of wheat flour with defatted flaxseed flour confirmed the assumption about the advisability of introducing the latter into the atola recipe. Thus, the mass fraction of protein and fat in flax pulp was on average 1.3 and 28.2 times (according to dry weight) higher than the same values in grade 1 flour and, correspondingly, 1.4 and 19.3 times higher in wallpaper flour. In the studied mass, on average, there was 2.6 and 1.2 times more iron than similar values in the comparison samples, and an increased amount of fiber. Significant differences were also found in the content of vitamins. Thus, the total amount of vitamins in the studied raw materials is almost 4.0 and 3.6 times greater than in the comparison samples.

It should be noted the high content of tocopherols in flax seed oil. In terms of energy value, this raw material exceeds the similar values of comparison samples by 49.8 and 52.5%, respectively.

It is more rational to introduce non-skimmed flaxseed flour into fat to simultaneously optimize the fatty acid composition of the latter. It is also advisable to combine animal fats with liquid vegetable oils, in particular with sunflower oil (MP). Typically, to achieve a more optimal ratio of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids, the recommended ratio of vegetable oil to animal fat in the mixture is 1:2 or 3:7. In this regard, to compose a functional fat and flour mixture, the fat component was prepared by mixing lamb fat and sunflower oil (RZS-vegetable-fat mixture), as well as ghee and sunflower oil (RSS-vegetable-butter mixture), respectively, in a ratio of 2:1.

To optimize the ratio of PUFAs of the ω-6 and ω-3 families, LM was added to these fat mixtures, the mass fraction of oil in which was 39%.

The fatty acid composition of oils is presented in Table 2.

The calculation of the required ratio of the selected fat components and LM was carried out in accordance with the Microsoft Excel program. As a result of calculations, it was established that the ratios RFA: Lflour = 13:1 and RSS: Lflour = 14:1 provide the necessary ratios of PUFA families ω-6: ω-3 ≈ 10:1. These ratios may vary slightly depending on the botanical oil content and PUFA content in the selected variety of oilseed flax, which can be easily calculated using the compiled Microsoft Excel program [4-6].

The ratios of fats in the compositions presented in Table 2 are calculated taking into account possible approximation to the optimal fatty acid composition both in terms of the SFA:MUFA:PUFA ratio and the ratio of PUFAs of the ω-6:ω-3 families.

It was established that the composition of control fat products (samples 1 and 2) is unbalanced and is characterized by a clearly increased content of SFAs and a decreased content of PUFAs. Obviously, against the background of a clear deficiency of PUFAs, the ratio of fatty acids ω-6 and ω-3, which at first glance seems acceptable for therapeutic nutrition, does not have significant physiological significance.

Table 2. Mass fraction of fatty acids in fats, oils, crushed seeds and

Fatty acid	*Samples*										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	Lamb fat (*LF*)	**Creamy melted butter (*MB*)**	**Flaxseed oil (*FO*)**	**Oil Sunflower (*SO*)**	**Flax pulp fat content 39% (*FP*)**	***VFM (SO+ LF* = 1:2)**	***VCM (SO+ MB* = 1:2)**	**Mixture *VFM* + *FO*=33:1**	**Mixture *VCM* + *FO*= 35:1**	**Mixture *VFM* + *FP*=13:1**	**Mixture *VCM* + *FP*= 14:1**
Saturated (NZHK)	55.0	62.2	10.6	11.3	4.13	40.43	45.2	39.6	44.2	38.3	42.5
Monounsaturated (NZHK)	40.5	33.1	26.4	26.4	10.3	35.8	30.9	35.5	30.8	35.1	29.5
Polyunsaturated (PSFA): linoleic (ω-6); linolenic (ω-3)	3.32 1.20	3.41 1.32	14.50 48.53	62.11 0.22	5.51 18.70	22.90 0.87	22.70 0.93	22.70 2.27	22.50 2.25	21.60 2.14	21.50 2.10
Ratio ω-6:ω-3	2.75:1	2.61:1	0.3:1	310.5:1	0.3:1	26.3:1	24.4:1	10:1	10:1	10.1:1	10.2:1

Note: RFA is a vegetable-fat mixture of sunflower oil and animal fat in the ratio 1:2 (SO+ LF = 1:2);

RCC – vegetable-cream mixture of sunflower oil and melted butter in the ratio 1:2 (SO+ MB= 1:2); composite mixtures, %

Mixing lamb fat and sunflower oil (RZS–vegetable-fat mixture), as well as ghee and sunflower oil (RSS–vegetable-cream mixture), respectively, in a 2:1 ratio (samples 6 and 7) helps to achieve a significant balance in the fatty acid composition of the mixture according to the ratio of SFA: MUFA: PUFA, however, the ratio of PUFA ω-6: ω-3 is not yet optimal

for a healthy diet. Optimization of the ratio of PUFA ω-6:ω-3 can be achieved by adding flaxseed oil to RFA or RSS, respectively, in ratios of 32:1 and 35:1 (samples 8 and 9). But using LM instead of linseed oil, due to the advantages of its composition outlined above and ease of use, is more profitable from both a technological, physiological, and economic point of view [7-8]

As follows from the data in Table 2, adding LM to RFA or RSS, respectively, in ratios of 13:1 and 14:1 (samples 10 and 11) helps to obtain similar results in optimizing the fatty acid composition as in samples 8 and 9. At the same time, fortification of functional The improvement in the properties of the finished fat and flour mixture (the fat base of flour soup) also occurs due to the replacement of a certain part of the flour with wheat flaxseed flour.

Using the combination effect allows you to increase the nutritional value of products by significantly increasing the content of physiologically significant limiting nutrients in them.

The chemical composition of traditional grade I wheat flour (option 1), wheat wallpaper (option 2) and experimental samples of atola flour-fat mixtures without adding eggs, but using LM (option 3) is presented in Table 3.

Analysis of the data obtained showed that in the studied product samples the ratio of proteins, fats and carbohydrates differs from the "ideal" one, the most favorable for maximum satisfaction of both the plastic and energy needs of the human body. The closest to the ideal ratio of proteins and fats are samples with inclusion of LM.

Another important aspect of the quality of mixtures is the presence and balance of minerals and vitamins in them. Thus, in the studied mixtures there is an excess content of phosphorus and magnesium in relation to calcium, which reduces the degree of absorption of these elements by the human body. The closest to the recommended ratio of calcium and magnesium is set in option I, and calcium and phosphorus - in option III.

Table 3. Nutritional value and degree of satisfaction of daily requirements upon consumption 100 g atola (without eggs).

Nutrients	Daily allowance need	Mass fraction of nutrients, g/100 g mixture			Degree of satisfaction of daily nutritional needs, %		
		№1	№2	№3	№1	№2	№3
Proteins, g (P)	80-90 (85)	7.57	8.93	10.33	8.91	10.51	12.15
Fat, g (F)	80-100 (90)	29.53	30.00	32.73	32.81	33.33	36.37
Carbohydrateg (C)	382	52.26	48.70	47.48	13.68	12.75	12.43
Fiber, g	25	0.14	1.36	2.50	0.56	5.44	10.00
P:F:C	1.0:1.0:4.0	1.0:3.9:6.9	1.0:3.4: 5.4	1.0:3.2: 4.6	-	-	-
Minerals, mg:							
calcium	900	17	28	31	1.90	3.10	3.44
magnesium	400	31	67	70	7.75	16.75	17.50
phosphorus	1250	82	94	99	6.56	7.52	7.92
iron	15	0.6	1.3	1.5	4.00	8.67	10.00
Ca: Mg	1.0:0.5 (before 0.7)	1.0:1.8	1.0:2.4	1.0:2.3	-	-	-
Ca: P	1.0:1.4 (before 2.0)	1,0:4,8	1,0:3,3	1,0:3,2	-	-	-
Vitamins, mg:							
thiamine, B1	1,5-2,0 (1.75)	0.07	0.11	0.14	4.00	6.30	8.00
riboflavin, B2	2,0-2,5 (2.25)	0.02	0.04	0.07	0.90	1.80	3.11
niacin, PP	15-25 (20)	0.62	1.54	1.50	3.10	7.70	7.50
tocopherols, E	5-30 (17.5)	0.84	-	0.37	4.80	-	2.11
Energy value, kcal	2850	492.0	488.3	513.94	17.30	17.10	18.00

Note: №1 – FFM $W_{f.}$; №2- FFM c $W_{p.}$; №3- FFM with W_f and FP.

Flour products play a very significant role in covering the needs of an adult for vitamins such as E, B1, B2, B6, B9 and PP. In this regard, flour is enriched with synthetic vitamin

preparations. The need for vitamins E and B2 is poorly met. The use of LM will increase the mass fraction of vitamin B2 relative to comparison samples by an average of 3.5 and 1.7 times. It should be taken into account that as a result of thermal destruction, certain less thermostable vitamins (for example, B1, B2 and E) partially lose their activity [9-10].

The use of LM in the preparation of a semi-finished product for atola, which is MFS, has a number of advantages, since its preparation involves frying the flour in anhydrous fat, which will increase the degree of microbiological purity of the product and ensure its food safety. This heat treatment leads to a decrease in the enzymatic action of lipase, protease and lipoxygenase of the germ and, as a consequence, an increase in the shelf life of the mixture.

4 Conclusion

In general, analyzing the data obtained, we can conclude that the introduction of LM into the formulation of semi-finished products fundamentally changes the level of biological value of the product and improves its quality characteristics. Thus, the color of atol obtained using LM practically did not differ from the comparison samples, while it had a pleasant taste and aroma and dominated according to the results of sensory assessment.

Thus, it has been established that non-fat flaxseeds, which are a traditional food product, are a promising additive for mealy-fat composites with nutritional value and safety, which is especially important for the nutrition of pregnant and lactating women in the postpartum period.

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