

FATTY ACID COMPOSITION OF RICE FLOUR MILLET AND CHICKPEAS FOR THE PRODUCTION OF GLUTEN FREE BREAD

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Abstract

The fatty acid spectrum of gluten-free flours, which is predominantly represented by unsaturated fatty acids ranging from 74.78% to 85.4% of the fat fraction, has been studied. The amount of SFA in different flours varies from 14.35% to 25.09%.

The total omega-3 fatty acid content in the gluten-free meals tested ranges from 1.17 g/100 g fat in millet flour to 2.46 g/100 g fat in chickpeas flour.

Omega-6 fatty acids have a high value due to the high linoleic acid content. Based on the study, the extremely low content of omega-3 fatty acids has been found, as a result of which the ratio between the two groups of fatty acids-omega-6 and omega-3 is relatively high- 22.26 in the chickpeas flour, 30.07 and 30.34 for rice flours and 53.92 for millet flour.

The purpose of the study is to select suitable flours according to its fatty acid composition to obtain gluten-free bread. From the study it was found that when glues of rice, millet and chickpeas are put in suitable proportions, gluten-free bread with good technological parameters can be obtained.

Key words: rice, millet, chickpeas, flours, gluten-free bread, fatty acid composition.

INTRODUCTION

Recently, demand for gluten-free products has increased, due to the increased consumer awareness. People suffering from gluten intolerance need to eat gluten-free foods. In order to produce such foods, it is necessary to study the gluten-free flours and to put them in the appropriate proportions (Arendt, 2012; Borisova, 2015). Celiac disease is an autoimmune disease of the small intestine, which leads to the malabsorption of several important nutrients, finding a lack of iron, folic acid, calcium and fat-soluble vitamins. Anemia, mouth ulcers, diarrhea or constipation, abdominal pain, bloating, fatigue, osteoporosis, infertility, cancer, anxiety and depression are the most important symptoms associated with this disease (Borisova, 2016; Karadzhov et al., 2007; Koinov, 1983; Koinov & Radkov, 1981). Studies have shown that the disease affects about 1% of the population. Throughout their lives, patients with this disease have an intolerance to the prolamine fraction of wheat (gliadins), rye (chakras) and barley (chordines). Celiac disease is a global phenomenon and its prevalence is greatly increased due to improved

diagnostic procedures and changes in eating habits (Kotsev, 2012; Kozmina, 1971; Torbica, 2010). The fatty acid composition of gluten-free flours is mainly represented by unsaturated fatty acids. Omega-6 fatty acids have a high value due to the high content of linoleic acid in cereals at the expense of shorter and medium-chain fatty acids that are missing (Vangelov, 1999; Zannini et al., 2010).

MATERIALS AND METHODS

Organoleptic assessment

Organoleptic evaluation of the raw materials - appearance, color, taste, aroma. The breads developed were organoleptically evaluated on the 9th Bald Hedonic Scale (Lim et al., 2009).

Biochemical methods

Determination of fatty acid composition

The extraction of common lipids in flour and bread was performed by the method of Bligh & Dyer, the methyl esters of fatty acids (FAME) being analyzed using a Shimadzu-2010 gas chromatograph (Kyoto, Japan) equipped with a flame ionization detector and an automatic injection system.

RESULTS AND DISCUSSIONS

The fatty acid composition of gluten-free flours is mainly represented by unsaturated fatty acids ranging from 74.78% to 85.4% of the fat fraction. The amount of SFA in the various flours varies from 14.35% to 25.09% (Table 1). Fatty acid range of gluten-free flours (g/100 g fat).

Were used mixes of flours - rice, millet and chickpeas to produce gluten-free bread. In addition to the main flours, corn starch, crystalline sugar and beta-glycans are incorporated as auxiliary raw materials. Hydrocoagulants (carboxymethylcellulose, guar gum, and xanthan gum) are incorporated as structuring agents.

Flours need to be tempered at room temperature as they are stored in a dry and cool place. Of all the raw materials it is necessary to dispense the necessary quantities according to the gluten-free bread formula. Mix the dough by the single-phase method. The dies are placed in molds because the die-hardness of the gluten-free dough is weak, it is difficult to form a dough and spills.

The fermentation is carried out in a thermostat at 30°C for 15 minutes, mixing and another 20 minutes.

The final fermentation is 25 minutes.

Baking was done for 35 minutes at 200°C.

The fatty acid profile of gluten-free flours and bread is analyzed. The results are calculated in g/100 g of fat (Table 1).

Table 1. Fatty acid range of gluten-free flours (g/100 g fat)

Groups FA	Rice/ polished/	Rice /whole grain/	Millet	Chickpeas
SFA	25.09	20.53	14.65	14.35
MUFA	35.27	39.39	21.14	28.09
PUFA	39.50	39.84	64.10	57.26
cis- FA	33.92	37.73	20.22	26.52
Σ n-3	1.27	1.27	1.17	2.46
Σ n-6	38.25	38.57	62.93	54.81
Σ n-6/Σn-3	30.07	30.34	53.92	22.26
Branched	0.16	0.22	0.13	0.31

For rice flours, the ratio of monounsaturated to polyunsaturated is 1:1, while in millet and chick pea the content of PUFA to MUFA is 2 to 3 times higher. The most rich of polyunsaturated fatty acids is the millet flour, followed by chickpeas flour and rice flour.

Looking at the individual fractions, it is noteworthy that the fatty acid content is significant in the proportion of palmate (C16:0) and stearic (C18:0) fatty acids, while other saturated fatty acids are less than 1 g/100 g fat (Table 2).

Table 2. Fatty acid range of gluten-free flours (g/100 g fat)

SFA	Rice /polished/	Rice /whole grain/	Millet	Chickpeas
C-10:0	0.12	0.01	0.01	0.01
C-12:0	0.09	0.03	0.01	0.03
C-14:0	0.52	0.29	0.05	0.24
C-15:0	0.08	0.02	0.02	0.08
C-16:0	21.31	17.12	9.28	10.78
C-17:0	0.05	0.08	0.06	0.05
C-18:0	1.85	1.44	3.26	1.68
C-20:0	0.52	0.55	0.92	0.65
C-21:0	0.05	0.02	0.09	0.09
C-22:0	0.16	0.24	0.47	0.42
MUFA				
C-16:1n7	0.08	0.15	0.07	0.02
C-17:1n7	0.01	0.02	0.03	0.08
C-18:1c9	33.87	37.73	20.19	26.46
C-18:1c11	0.80	0.83	0.56	1.32
PUFA				
C-18:2c9,12	38.08	38.47	62.85	54.67
aC-18:3n3	1.20	1.22	1.12	2.34
C-22:2n6	0.14	0.04	0.00	0.07

Palmate acid (C-16:0) is the highest in rice flour, 21.31 g/100 g of fat, and the lowest in millet flour is 9.28 g/100 g of fat. Stearic acid (C-18:0) is in the largest quantities in millet flour - 3.26 g/100 g fat and with the lowest values for whole grain flour of rice - 1.44 g/100 g of fat.

Oleic acid in whole meal rice flour has the highest content of 37.73 g/100 g of fat and the lowest in millet flour of 20.19 g/100 g of fat and the vaccine acid in flour is less than 0.02 g/100 g of fat. Polyunsaturated fatty acids in the different types of flours are predominantly linoleic (C18:2) and aliened (C18:3n3) fatty acids. Linoleic acid has the highest content in the flour of millet - 62.85 g/100 g of fat and chick peas - 54.67 g/100 g of fat, while for the alanine highest value was found in chickpeas - 2.34 g/100 g fat. The total omega-3 fatty acid content (Table 7) in the gluten-free meals tested ranges from 1.17 g/100 g fat in millet flour to 2.46 g/100 g fat in chickpeas flour. Omega-6 fatty acids have a high value due to the high linoleic acid content. Based on the study, the extremely low content of omega-3 fatty acids has been found, as a result of which the ratio

between the two groups of fatty acids - omega-6 and omega-3 is relatively high - 22.26 in the chickpeas flour, 30.07 and 30.34 for rice flours and 53.92 for millet flour.

The fatty acid composition of gluten-free bread is shown in Tables 3 and 4. It consists predominantly of unsaturated fatty acids. Monounsaturated fatty acids are the highest in the mix 1 - 30.12 g/100 g of fat and the lowest at the mix 3 - 28.51 g/100 g of fat. In polyunsaturated fatty acids it was found that mix 3 had the highest content - 54.87 and mix 1 - with the lowest - 53.55 g/100 g of fat. Saturated fatty acids (NMCs) in the gluten-free bread tested range from 15.30 (mix 1) to 16.80 g/100 g of fat (mix 2). Of the saturated fatty acids, the share of palmate acid (C16:0) is significant, with the highest concentration being obtained in the mix 2 - 11.11 and the lowest in the mix 1 - 10.19 g/100 g of fat. Stearic acid in the mixes is from 3.84 at mix 1 to 3.34 at mix 2. Enriching rice flour with chickpeas and millet flour leads to a decrease in palmate acid concentration in new mixes and an increase in stearic acid content.

Table 3. Fatty acid range of gluten-free bread (g/100 g fat)

Groups FA	Bread mix 1	Bread mix 2	Bread mix 3
SFA	15.30	16.80	16.20
MUFA	30.12	29.20	28.51
PUFA	53.55	53.95	54.87
<i>trans</i> -FA	0.02	0.09	0.48
<i>cis</i> -FA	28.22	27.16	25.64
Σ n-3	0.63	1.26	1.01
Σ n-6	53.58	54.02	55.32
Σ n-6/Σn-3	84.94	43.02	54.90
<i>Branched</i>	0.35	0.42	0.51

Table 4. Fatty acid range of gluten-free bread (g/100 g fat)

SFA	Bread mix 1	Bread mix 2	Bread mix 3
C-10:0	0.00	0.17	0.16
C-12:0	0.02	0.04	0.04
C-14:0	0.29	0.57	0.33
C-16:0	10.19	11.11	10.46
C-18:0	3.84	3.34	3.56
C-20:0	0.28	0.41	0.26
C-22:0	0.42	0.55	0.29
MUFA			
C-16:1n7	0.07	0.13	0.11
C-17:1n7	1.17	0.01	0.02
C-18:1t9	0.14	0.02	0.11
C-18:1t10	0.03	0.00	0.15
C-18:1c9	27.47	26.25	24.63
C-18:1c11	0.75	0.88	0.59
PUFA			
C-18:2c9,12	53.55	53.95	54.87
αC-18:3n3	0.63	1.26	0.85
C-20:2n6	0.01	0.00	0.17
C-22:2n6	0.00	0.02	0.00
C-22:5n3	0.00	0.07	0.15

Oleic acid in the test mixes has the highest value at mix 1 - 27.47 and lowest at mix 3 - 24.63 g/100 g of fat. Vaccenic acid in the gluten-free bread analyzed is higher at mix 1 and mix 3 and 0.08 and 0.07 g/100 g, respectively.

Of the polyunsaturated fatty acids in the fat obtained from the different types of bread mix, the linoleic (C18:2) mixtures 1 - 53.55, mix 2 - 53.95 and 54.87 g/100 g fat and the alienated (C18:3n3) - from 0.63 to 1.26 g/100 g of fat. The enrichment of rice flour with millet flour and chickpeas leads to an increase in linoleic acid.

The total content of omega-3 fatty acids in the gluten free bread is low and ranges from 0.63 (mix 1) to 1.26 (mix 2) g/100 g fat and 53.55 to 54.87 g/100 g fat in omega-6 fatty acids.

CONCLUSIONS

The amount of SFA in different flours varies from 14.35% to 25.09%.

For rice flours, the ratio of monounsaturated to polyunsaturated is 1: 1, while in millet and chickpea the content of PUFA to MUFA is 2 to 3 times higher. The highest content of polyunsaturated fatty acids was found in millet flour, followed by chickpeas and the lowest in rice flour. The total omega-3 fatty acid content in the gluten-free meals tested ranges from 1.17 g/100 g fat in millet flour to 2.46 g/100 g fat in chickpeas flour. Omega-6 fatty acids have a high value due to the high linoleic acid content. Based on the study, the extremely low content of omega-3 fatty acids has been found, as a result of which the ratio between the two groups of fatty acids - omega-6 and omega-3 is relatively high - 22.26 in the chickpeas flour, 30.07 and 30.34 for rice flours and 53.92 for millet flour.

Flour from rice, millet and chickpeas are extremely suitable for the production of gluten-free bread.

Based on the study, we found low omega-3 fatty acids, resulting in a ratio between the two groups of fatty acids-omega-6 and omega-3 with a high coefficient above 40. The gluten-free bread is rich in oleic and linoleic acid.

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