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SUPPLEMENTATION OF WHEAT FLOUR WITH SOY FLOUR, SENSORY AND PHYSICO-CHEMICAL EVALUATION OF FORTIFIED BISCUITS

Flavia POP[1]*, Zorica VOŞGAN[1], Lucia MIHALESCU[1]

[1]*Department of Chemistry and Biology, Technical University of Cluj-Napoca, North University Center of Baia Mare, 76A Victoriei str., 430122, Baia Mare, Romania,*
*Corresponding author: flavia_maries@yahoo.com
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Abstract: *The research was conducted in order to evaluate the physico-chemical and quality characteristics of biscuits fortified with soy flour that could be used as a protein supplemented food. Wheat flour has been replaced at different levels with soy flour that were 30% (R4), 20% (R3), 10% (R2) and without soy flour, control (R1). The fat content of control was 16.36% and increased to 19.4% in the case of 30% soy flour formulation that could be due to the increase in the proportion of soy flour in the flour blend. The highest mineral content was obtained in R4 (1.98%) and the lowest in R1 (0.552%), soy flour brought a significant contribution to mineral substances, and the ash content increased gradually with the increase in the percentage of soy flour. From the sensory evaluation, the biscuits with 10 and 20% soy flour addition presented similar characteristics, biscuits supplemented with up to 20% soy flour have shown superior nutritional characteristics as compared to wheat flour biscuits.*

Keywords: *soy flour, biscuits, fat content, saturation capacity, sensory evaluation.*

1. Introduction

Soy is particularly rich in lecithin, a very valuable emulsifier, in proteins and polyunsaturated fatty acids. The water absorption capacity of soy flour is much higher than that of wheat flour. In combination with wheat flour, soy flour is used for the preparation of bread or various pastry products. Soy flour does not contain cholesterol, is ideal for people who are lactose intolerant, does not contain gluten, is rich in fat but poor in starch. Soy flour contains vitamins B, vitamin E, magnesium, phosphorus and calcium [1, 2].

Cracked biscuits are prepared from flour with medium or low gluten, because a high gluten content leads to hard biscuits.To reduce the high gluten protein content of a flour, it can be used wheat, potato or corn starch, which reduces the elasticity and increases the plasticity of the dough. Due to its complex composition, the biscuits dough is more difficult to prepare compared to the dough intended for bread preparation, because additional additives reduce the moisture capacity of the flour and gluten elasticity [3-6].

The dough for sugary biscuits involves an initial mixing of powdered sugar with fats, until it reaches an aliphous consistency without any roughness. The cream is mixed with sugars, eggs and essences homogenised in advance, and finally the flour is added. After homogenization the leavening agents are added and the kneading continues for 20-30 minutes. The increasing of the mixture temperature to an optimal value, favors the fluidization of certain components, the ability to hydrate the flour and reduce kneading time. Although in dough with higher humidity the development of the gluten network is

faster, it is not recommended to use a very wet dough, because it occurs a negative influences on the texture and shape of biscuits. After kneading the dough is left at rest, when the dough is matured, by repairing gluten threads damaged at kneading, that leads to the improvement of the rheological characteristics of the dough [7-9].

During the rest, the decomposition of the leavening agents begins, under the action of component acidity; the resulting gases loosen the dough and diminish its consistency. Inappropriate storage or low humidity, leads to defective biscuits such as absence of volume and porosity, ruptures, surface blisters. Also, if the thickness of the dough layers is too high, the dough layers in the lower part are heated, chemical decomposition is very fast and they break apart completely during the resting phase. The formed gases will be largely eliminated at rolling and the final products will have low porosity and volume. The cooling of biscuits should be done as soon as possible, to strength the structure of the product, making it more resistant [10-12].

The objective of the study was to fortify wheat flour with soy flour at different levels that were 30% (R4), 20% (R3), 10% (R2) and without soy flour as control (R1) and to study their effects on the biscuits quality. To assess the quality of biscuits the following parameters were determined: fat content, alkalinity, determination of total ash, saturation capacity, acidity and moisture content during storage, as well as sensory analysis.

2. Materials and methods

Materials

Wheat flour was replace with soy flour in three proportions 30% (R4), 20% (R3) and 10% (R2) respectively, whereas R1 was kept as control (without soy flour).

Table 1.

Formulation of the biscuits

Samples	Wheat flour (%)	Soy flour (%)	Sugar (g)	Butter (g)	Sodium bicarbonate (g)
R1	100	0	100	100	1.0
R2	90	10	100	100	1.0
R3	80	20	100	100	1.0
R4	70	30	100	100	1.0

The fineness or size of the flour particles are of particular importance because influences the rate of colloidal and biochemical processes and the baking characteristics of the dough.

Wheat flour contains 12% proteins, 70% carbohydrates, 2% lipids, 14% water, as well as mineral substances, vitamins and pigments [4].

Physicochemical examination

Acidity is based on the extraction of the biscuits acids and their titration with sodium hydroxide 0.1 N, using phenolphthaleine, as an indicator. Acidity was expressed in mL of NaOH 0.1 mol/L solution by 100 g of biscuits [13].

Fat content was determined by Soxhlet method witch consisted of extracting the fat from the analyzed sample with ethyl ether. Determination of moisture content is based on drying of a sample with known initial mass to a constant mass. Alkalinity determination is based on the titration of the alkaline substances extracted from the product with HCl solution in the presence of blue-bromo-thymol. The alkalinity of pastries was expressed in degrees. Degrees of alkalinity mean the number of milliliters of acid, normal solution, used to neutralize the alkalinity from 100 g of a product and based on dry matter. Determination of total ash is based on the calcination of a known mass of product up to constant weight [13].

Saturation capacity consists in weighing of one or two biscuits that are placed in a pot

of water and allowed to soak for 15-20 minutes, and then are weighed again. Determination of elasticity is based on the application of an known external force on the dough of known initial length and tracking its response.

To assess the normal taste of biscuits we used the descriptive sensory analysis, which is an ideal technique to identify flavors in a product and to distinguish the products between them, using tasters familiar with methods of scoring and sensory language.

Sensory analysis was performed on a sample of 10 trained panelist, aged between 20 and 55 years, according to the method described by Farzana and Mohajan, [14].

Values of different parameters were expressed as the mean ± standard deviation. Significant differences between samples were tested by Student's t-test.

3. Results and discussion

Dough acidity increased directly proportional with the increase of soy flour content in the biscuits formulatios. According to Farzana and Mohajan, soy flour has a 24.9% fat content in the nutritional composition, and brings a significant contribution of fatty acids to biscuit dough, and it represents a source of linoleic and linolenic acids that are not produced by the body [14].

The dough lost from elasticity directly proportional with the increase of soy flour and the reduction in gluten content.

The fat content of control biscuits was 16.36% and increased to 19.4% in the case of 30% soy flour formulation (Table 2).

The increase in fat content is in agreement with several studies [7, 9, 10]. The increase in the present study could be explained as soy flour is considered as an edible oil source, containing a higher percentage of fat than wheat flour. Farzana and Mohajan reported that the fat content of soy flour is between 20-24%, the white wheat flour has a 0.9-1.1% content and most of them are unsaturated fatty acids. The trend of increase in fat content could be due to the increase in the proportion of soy flour in the flour blend [14]. The highest mineral content was determined for R4 (1.98%) and the lowest for R1 (0.552), soy flour brought a significant contribution to mineral substances. The data showed that the ash content gradually increased with the increase in the percentage of soy flour, results which are in agreement with the findings of Ayo et al., and Siddiqui et al., on the supplementation of soy flour for the preparation of biscuits [15, 16].

Acidity presented an increasing trend during four weeks storage, due to the hydrolysis processes occurring in the fat formulation. Biscuits presented a higher acidity than the dough, due to the amount of carbon dioxide resulted from thermal decomposition of chemical agents. A more pronounced increase in acidity was recorded for R3 and R4 (Fig. 1).

In the present study, the highest moisture content was determined for wheat flour biscuits (3.6%), and the content gradually decreased to 2.07% for biscuits supllemented with 30% soy flour. The data showed that moisture decreased with the increase in soy flour witch is in agreement with the study of Banureka and Mahendran [17]. This may be explained by the fact that soy flour contains a higher amount of solid dry substance with emulsifying properties compared to wheat flour. During biscuits storage the moisture content increased, but R3 and R4 showed greater storage stability (Fig. 2). The saturation capacity decreased during four weeks of storage, between the moisture content and saturation capacity there was an inverse correlation (Fig. 3).

Table 2.

Proximate analysis of biscuits

Parameters	R1	R2	R3	R4
Fat (%)	16.34 ± 0.03	17.31^{a} ± 0.02	19.07^{b} ± 0.05	19.84^{bc} ± 0.06
Moisture (%)	3.62 ± 0.08	2.95^{a} ± 0.04	2.63^{ab} ± 0.02	2.07^{b} ± 0.03
Ash (%)	0.75 ± 0.01	1.45^{ab} ± 0.05	1.59^{b} ± 0.06	1.86^{bc} ± 0.01
Alkalinity (degrees of alkalinity)	2.73 ± 0.02	2.38^{a} ± 0.01	1.82^{ab} ± 0.01	1.25^{b} ± 0.04
Saturation capacity (g)	14.31 ± 0.05	18.82^{ab} ± 0.03	21.76^{b} ± 0.04	23.54^{bc} ± 0.02
Dough elasticity (%)	40.63 ± 0.04	29.35^{bc} ± 0.04	26.12^{c} ± 0.03	23.78^{cd} ± 0.05

Values are means of triplicates ± standard deviation. Values with the same superscript in a column are not significantly different (P > 0.05).

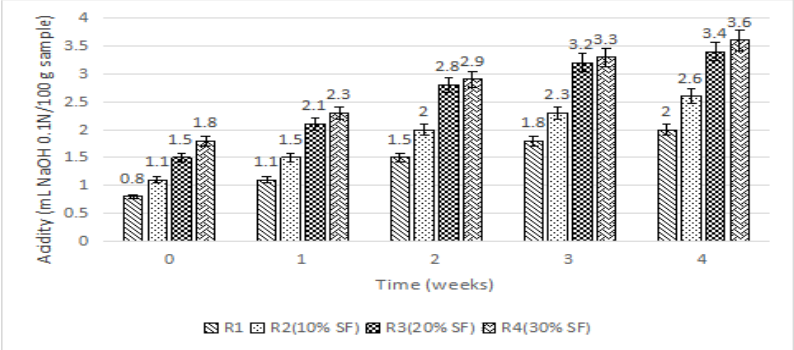

Fig. 1. Acidity variation during storage of biscuits

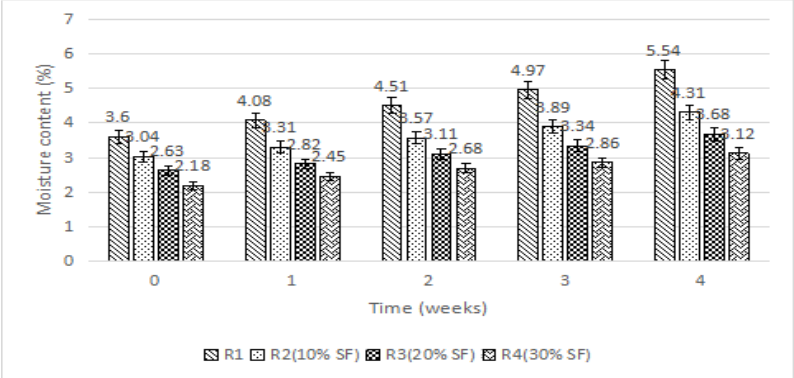

Fig. 2. Moisture variation during storage of biscuits

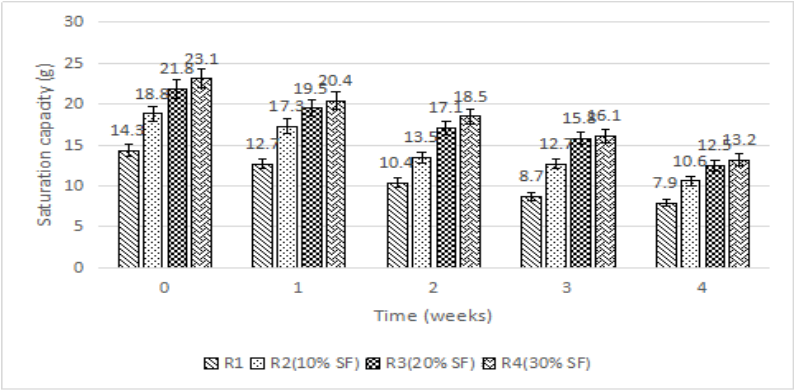

Fig. 3. Saturation capacity variation during storage of biscuits

Farzana and Mohajan studied the incorporation of soy flour to wheat flour and the quality of biscuits fortified with mushroom. The researchers reported that protein content of soy flour-supplemented biscuits increased from 11.07% to 17.86% as compared to control and a significant increased in fat (17.36-20.89%), fiber (0.48-0.92%), iron (1.56-1.99 mg/100 g), and energy value. The results from chemical analyses indicated that good quality biscuits can be prepared by replacing wheat flour with 15% soy flour and addition of mushroom powders may affect the backing quality [14]. Mildner-Szkudlarz *et al.*, studied the incorporation of white grape pomace in wheat flour at levels of 10, 20 and 30% and its influence on rheological, nutraceutical, physical and sensory properties of dought and biscuits. The researchers concluded that dough with different levels of white grape pomace showed a decrease in water absorption and the addition of white grape pomace reduced hardness and caused deterioration in brightness and yellowness of all the enriched samples. The results showed that the smallest addition of white grape pomace caused an approximately 88% increase in total dietary fibre content as compared to control. The content of phenolic compounds increased with the addition of white grape pomace and enhanced the antioxidant properties of biscuits, while acceptable biscuits were obtained when incorporating 10% white grape pomace [18]. To assess the state of freshness we used the descriptive sensory analysis, which is an ideal technique to identify flavors in a product and to distinguish the products between them, using tasters familiar with methods of scoring and sensory language.

The organoleptic test of the products was done by the 5-point hedonic scale and was performed on a sample of 10 trained panelist, aged between 20 and 55 years, according to the method described by Farzana and Mohajan, [14]. Selected attributes were: smell, taste, color, appearance and texture (Fig. 4-6).

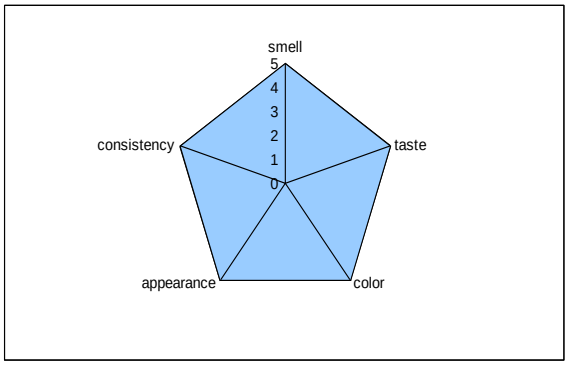

Fig. 4. Sensory analysis of biscuits with 10% soy flour incorporation

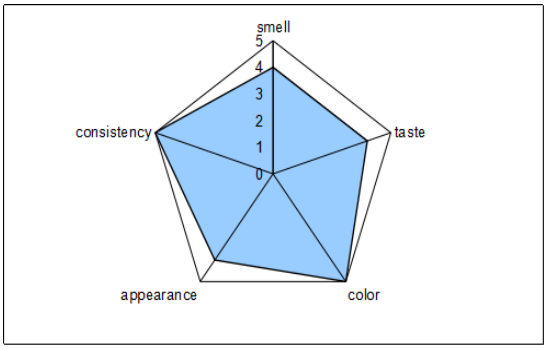

Fig. 5. Sensory analysis of biscuits with 20% soy flour incorporation

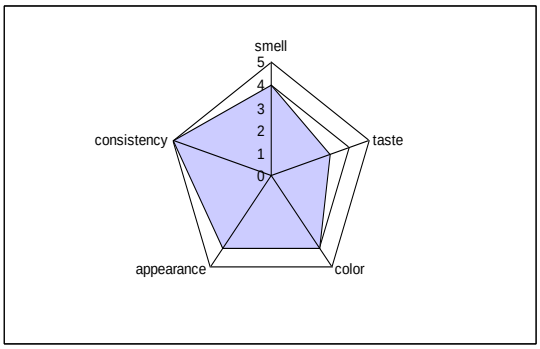

Fig. 6. Sensory analysis of biscuits with 30% soy flour incorporation

For sensory analysis the descriptive scale was the following: *1 = very little normal, 2 = less than normal, 3 = moderately normal, 4 = almost normal, 5 = normal*. The taste is the primary factor which

determines the acceptability of any product, which has the highest impact as far as market success of product, is concerned. In the present study, sensory scores of biscuit enriched with 10% (R2) and 20% (R3) soy flour, showed that with regard to taste, color, smell, appearance, and consistency, the sensory characteristics of R2 were found to be the best.

4. Conclusions

During four weeks of storage at ambient temperature, acidity and moisture content showed an upward trend and were within the maximum admissible limits. Biscuits fortified with soy flour had a higher fat and mineral content as compared to wheat flour biscuits. From the sensory evaluation, the biscuits with 10 and 20% soy flour addition presented similar characteristics. The biscuits supplemented with up to 20% soy flour have shown superior nutritional characteristics as compared to wheat flour biscuits. Soy flour can be used efficiently in biscuit production technology.

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