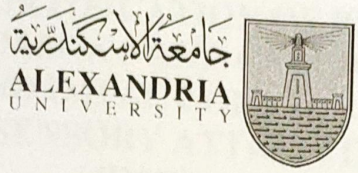

ALEXANDRIA UNIVERSITY
High Institute of Public Health
Department of Nutrition

Effect of Fortification of Biscuits with Flaxseed on Omega 3 and Calcium Content of Products and Impact of Storage on Lipid Oxidation and Sensory Attributes of Produced Biscuits

Thesis

Submitted to Department of Nutrition

High Institute of Public Health- University of Alexandria

In Partial Fulfillment of the requirements for the degree of

Master Degree of Public Health Sciences in

(Food Analysis)

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B.Sc, Faculty of Science, Alexandria University, 2002

2017

SUMMARY

Consumer's interest in healthy eating, in the last decades, shifted towards the potential health benefits of specific foods and food ingredients. Foods are not intended to only satisfy hunger and to provide basic nutritional requirements but also to prevent nutrition-related diseases and to improve physical and mental wellbeing of the consumers.

The benefits of flax have passed all expectations. The seeds are widely used medicinally. Flaxseed contains functional components such as dietary fiber, oil, protein and phenolic compounds including lignans, flavonoids and phenolic acids, which are responsible for a number of health benefits.

Flaxseed has a unique fatty acid profile. It is high in polyunsaturated fatty acids (alpha-linolenic acid (ALA) the essential omega-3 fatty acid and Linoleic acid an omega-6 fatty acid) and low in saturated fatty acids

The health benefits of ω-3 fatty acids have been widely reported for several conditions including cardiovascular disease, hypertension, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorders

Flaxseed flour contains high a concentration of calcium, which is a key component to mineralize the bone matrix, and ALA which increases calcium absorption in the gut, promoting deposition of mineral in bones.

Biscuits are the most popular bakery product consumed nearly by all levels of society. This is mainly due to its ready to eat nature, good nutritional quality, availability in different varieties, affordable cost and long shelf life

The storage stability of flaxseed is of major importance before using it in any food product. Due to its high oil content, proper storage assures better stability of high oil-containing flaxseeds in different products

The purpose of this study is to highlight the nutritional properties of flaxseed and effect of fortification of biscuits with flaxseed on omega 3 and calcium content of products and impact of storage on lipid oxidation and sensory attributes of produced biscuits. The Specific objectives of the present study were to 1. determine proximate analysis of flaxseed and biscuits produced from it including moisture, fat, total ash, crude protein, crude fiber, and carbohydrate content. 2. evaluate sensory characteristics of biscuits including color, taste, odor, texture, over-all acceptability and residual after taste. 3. detect omega-3 content and calcium content by testing fatty acid profile of produced biscuits. 4. assess the effect of storage on proximate analysis, sensory characteristics, fatty acid profile and calcium content. 5. detect the rancidity of flaxseed and the produced product after 2, 4, 6 and 8 weeks of storage.

One kilogram (1kg) of biscuits containing different flaxseed concentration (10%, 20% and 30%) in addition to control were prepared; the 1 kg will be divided into

4 portions (250 gram each), 10%, 20% and 30% and stored at room temperature for 2, 4, 6 and 8 weeks.

Determine proximate analysis of flaxseed and biscuits produced from it including moisture, fat, total ash, crude protein, crude fiber, and carbohydrate content.

Evaluate sensory characteristics of biscuits including color, taste, odor, texture, and over-all acceptability.

Detect omega-3 content and calcium content by testing fatty acid profile of produced biscuits.

Assess the effect of storage on proximate analysis, sensory characteristics, fatty acid profile and calcium content.

Detect the rancidity of flaxseed and the produced product after 2, 4, 6 and 8 weeks of storage.

In the present study, the moisture content of whole flaxseed was 5.3%, the fat, total ash, protein, crude fiber and the total carbohydrate content were 21.9%, 3.13%, 25.8%, 1.3%, and 43.8% respectively.

The changes in chemical composition of biscuits fortified with flaxseed showed that the addition of flaxseed to wheat flour at different concentrations (10%, 20%, 30%) significantly increased the protein, fat and ash content. Meanwhile, the content of carbohydrates decreased in the biscuits substituted with flaxseed. This is beneficial from nutritional point of view, since it increases the quantity and quality of amino acids and minerals, while decreases the total calories that acquired from this product.

The results concerning sensory evaluation of biscuits produced from different concentrations of flaxseed shows that biscuits samples made from substitution of wheat flour with flaxseed up to 20% were acceptable and gave somewhat similar scores to the control.

Flaxseed contains a mixture of fatty acids. Flaxseed oil is low in saturated fatty acids (20.05 %), moderate in monounsaturated fatty acids (26.78 %), and rich in polyunsaturated fatty acids (60.43 %).

From the obtained results it could be observed that the major fatty acids in flaxseed oil were α-linolenic acid C18:3 (omega-3) representing 47.22%, followed by oleic acid C18:1 as 26.78% and linoleic acid C18:2 (Omega-6) representing 13.21%.

The fatty acid profile of biscuits fortified with flaxseed revealed that polyunsaturated fatty acids, the linolenic acid, content of flaxseed fortified biscuits was significantly higher than the control biscuits.

In the present study, the P/S ratio increased from 0.20 in the control biscuits to 0.39, 0.50 and 0.62 in the flaxseed fortified biscuits with flaxseed concentration of 10%, 20% and 30% respectively. On the other hand, the ω-6/ω-3 ratio decreased from

8.5 in control biscuits to 1.38, 1.00 and 0.77 in flaxseed fortified biscuits with flaxseed concentration of 10%, 20 % and 30% respectively as a consequence of the α-linolenic acid increment.

In the present study, the calcium content of the grinded flaxseed was 188.9. Control biscuits which were formulated from wheat flour contained 25.6 mg/100g calcium. Whereas, biscuits fortified with 10 %, 20% and 30% flaxseed exhibited significantly higher contents of calcium as 168.3, 175.0 and 179.1 respectively.

Storing grinded flaxseed and biscuits fortified with it at ambient temperatures for 2 weeks did not cause noticeable changes in the proximate composition of them.

Sensory scores of biscuits fortified with 10%, 20% and 30% flaxseed stored for 2, 4, 6 and 8 weeks decreased slightly at the ambient conditions throughout the storage period but were still acceptable.

Fatty acid profile of grinded flaxseed showed no significant changes during storage up to four weeks at room temperatures.

In the present study, the calcium content of the grinded flaxseed, freshly prepared and stored flaxseed biscuits showed that there were no significant changes of the calcium content during the storage.

The chemical quality assurance criteria, including the acidity, peroxide value (that measures initial oxidation), ρ-anisidine value (that determines secondary oxidation products) and iodine value were determined.

The acid value of the freshly grinded flaxseed oils was 2.90%, the value significantly increased during storage but still below the acceptable value during storage up to two weeks.

In the present study, the peroxide value of grinded flaxseed and fortified biscuits significantly increased in comparison to the freshly prepared but still below the acceptable value during storage up to four weeks in case of flaxseed and two weeks for biscuits.

The para-anisidine value obtained in the present study showed no significant increase during the two weeks of storage.

In the present study unsaturated fatty acids were stable during two weeks storage period. As expected, unsaturated fatty acids declined during storage. Decreasing of unsaturated fatty acids was associated with decline in iodine value.

In the present study, flaxseed fortified biscuits were stable over two weeks of storage. At the same time, panelists were not able to detect a difference in the sensory characteristics between the freshly prepared or stored biscuits.