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Influence of Storage Conditions on the Quality Characteristics of Wheat-Defatted Coconut Flour Biscuits Packed in Metalized Polypropylene

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***Abstract* — Defatted coconut flour was blended with wheat flour at different levels to prepare nutritive biscuits. Nutritional, sensory and microbial quality was assessed to find out the most appropriate level of defatted coconut flour incorporation. On the basis of sensory analysis three different compositions of biscuit samples were selected along with the control treatment. Acceptability of enriched biscuits was affected with progressive storage, however the product remained in high acceptability range for up to 12 weeks. The biscuits were stored safely in metalized polypropylene. Microbiological study depicted that microbial count was far below the permissible limits up to three months of storage of biscuits. From this research, the 40% defatted coconut flour added biscuit has the highest scoring in all aspects compared to other tested combinations. There is no remarkable changes in organoleptic characters were observed in biscuits packed in metalized polypropylene for a period up to 12 weeks of storage in ambient conditions of temperature 30°C and the RH of 75–80% indicating that the 40% defatted coconut flour added biscuits could be stored for 12 weeks without any significant changes in quality.**

Keywords* — *Defatted coconut flour; storage; wheat flour; microbial and sensoryqualities.

I. INTRODUCTION

Bakery products are the important source of nutrients. Different types of bakery products include bread, biscuits, pastries, cakes, buns, rusk, etc. Biscuits are the lowest cost processed food. They are easy to use during travelling. Biscuits are small baked products made principally from flour, sugar and fat. Biscuits typically have a moisture content of less than 4% and have a long shelf life of six months or more [1].

Shelf life is an important property of any food and is of interest to everyone in food chain from producer to consumer. Well planned and conducted consumer acceptability tests in the form of appropriate sensory analysis, is an important part of the shelf life evaluation of any product [2]. Moisture and water vapour transfer act as key influencing factor for shelf life [3]. Physicochemical changes in food during storage can cause loss of shelf life resulting deterioration of its quality [4]. Off-flavors, off-odours and loss of crispiness in packaged food are the major cause of consumer rejection. These might be caused by oxidative rancidity of packaged food, permeation, migration and reactions between packaging components with the food components [5]. Most food products rely on their particular packaging to achieve their expected shelf life.

Therefore, the present work was undertaken to evaluate the quality and shelf life of biscuits prepared with different level of defatted coconut flour incorporation. The aim was to investigate the quality changes and shelf life of the formulted biscuits during storage

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II. MATERIALS AND METHODS

The biscuits were made according to the following treatments. The biscuits were prepared by using a Creamery method. Biscuits were made at the incorporation of defatted coconut flour with the replacement of refined wheat flour at the level of 10, 20, 30, 40 and 50% in the standardized formulations. Following baking, that biscuits were packed in metalized polypropylene bags. These biscuits were assessed for nutritional, physical, microbial and organoleptic qualities.

Treatments:

T1 - 100% wheat flour (Control)

T2 - 90% wheat flour + 10% de-fatted coconut flour

T3 - 80% wheat flour + 20% de-fatted coconut flour

T4 - 70% wheat flour + 30% de-fatted coconut flour

T5 - 60% wheat flour + 40% de-fatted coconut flour

T6 - 50% wheat flour + 50% de-fatted coconut flour

Based on the quality evaluations, three best combinations along with the control treatment were selected for the storage studies. The quality parameters were tested once in two weeks up to 12 weeks.

A. Nutritional Analysis

The moisture, ash, protein, fiber and fat of the biscuits were determined according to the standard methods [6]. The soluble carbohydrate content was determined by calculating the difference. Data were analysed by Analysis of Variance (ANOVA) and the difference between means was compared using Duncan's Multiple Range Test (DMRT), through Statistical Analysis System (SAS) software statistical package.

B. *Sensory Analysis*

The sensory attributes including taste, texture, colour, flavour and overall acceptability were evaluate by a trained 30 – member panel. The evaluations were done either 10 am for the morning session and at 3 pm for the afternoon session. The Seven – point hedonic scale was used to evaluate the degree of liking (7) and disliking (1) for preference of the biscuits. The mean scores were tested using analysis of variance (ANOVA) method and difference were separated by Friedman test using SAS software statistical package.

The aerobic plate count was carried out using the method of Fawole and Oso [7]. Each sample of 10 g was taken aseptically and homogenized in 90 ml sterile distilled water using a blender (Philips Type HR 2815i) for 2 min. Serial dilutions (using 1 ml of homogenates) were made in 9 ml sterile distilled water, dispensed in test tubes. One millilitre of each dilution was pour plated in sterile Petri dishes, using the plate count agar (PCA, oxoid), incubated at 37°C for 24 - 36 h. Counts of visible colonies were made and expressed as log CFU/g sample.

II. RESULTS AND DISCUSSION

A. *Composition of Defatted Coconut Flour*

The nutritional composition of the coconut flour were moisture 4.2%, fat 9.2%, protein 12.6%, total sugar 13.7%, ash 8.2%, fiber 13.0% and soluble carbohydrate 39.1%. The values are in accordance with Marquez [8]. Composition of coconut flour depends on the retention components after the extraction of coconut oil from scraped coconut.

Based on the nutritional and sensory analysis of freshly made biscuits, the most preferred biscuits were selected for storage studies. These biscuits were packed in sealed laminate of aluminum foil which is commercially used to pack the biscuits. Biscuit packs were stored for 12 weeks under ambient conditions of average temperature 30ºC and RH of 75-80%.

The most preferred treatments:

T1 - 0% defatted coconut flour + 100% wheat flour (Control)

T3 - 20% defatted coconut flour + 80% wheat flour

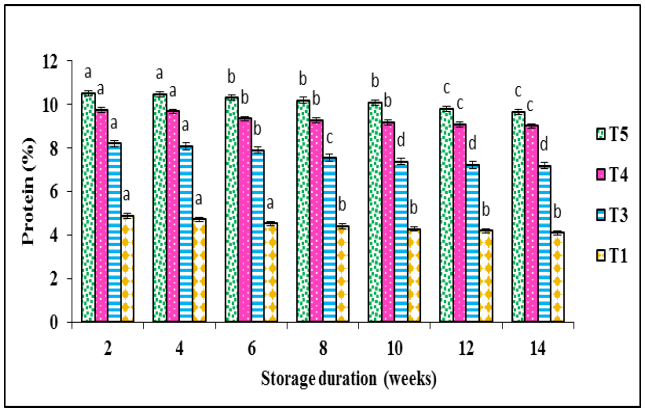
T4 - 30% defatted coconut flour + 70% wheat flour

T5 - 40% defatted coconut flour + 60% wheat flour

B. *Protein Content*

The various flour proteins present in wheat - defatted coconut flour can undergo changes such as protein cross–linking, protein–carbohydrate interactions and protein denaturation during processing and storage of foods, non–enzymatic reaction may cause food deterioration and reduce the shelf life [9]. The changes in protein content of the biscuits during the storage are shown below.

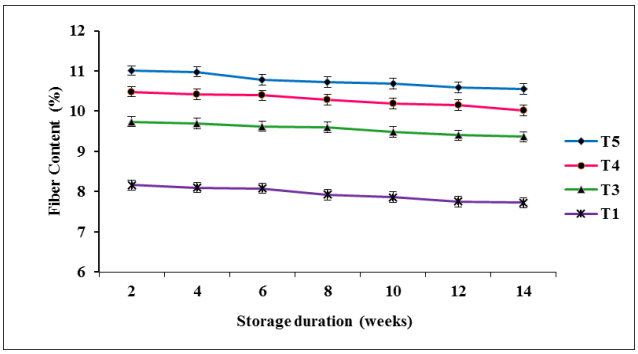
According to DMRT, protein content of biscuits decreased significantly ($p < 0.05$) throughout the storage period. This may occur due to the interaction between reducing sugars and amino acids (Maillard reaction) and it is a major cause of quality change and degradation of nutritional content of many foods.



The Maillard reaction impairs protein nutritional value [10] and also this reactions result in the loss of protein stability. Treatment T3 (20% defatted coconut flour added biscuit) and T4 (30% defatted coconut flour added biscuit) have the very slow rate of decreasing trend than the other treatments.

B. *Fibre Content*

Fiber content of stored biscuits decreased significantly during the storage period. The changes in total fiber content of the cookies during storage are shown in Figure below.



Processing involving heat – treatment may affect the dietary fiber in different ways. An increase temperature leads to a breakage of weak bonds between polysaccharide chains. Reactions during processing that may affect the dietary fiber content and its properties are leakage into the processing water, formation of Maillard reaction products thus adding to the lignin content and formation of resistant starch fractions.

According to DMRT, fiber content decreased significantly, ($p < 0.05$) through the storage period. Fiber content in all treatments has very little changes during the storage. Even though, T3 (20% defatted coconut flour added biscuit) has the very slow rate of decreasing trend than all other treatments. There was no significant difference in fiber content of T5 (40% defatted coconut flour added biscuit) from the 4th week until the end of the study period.

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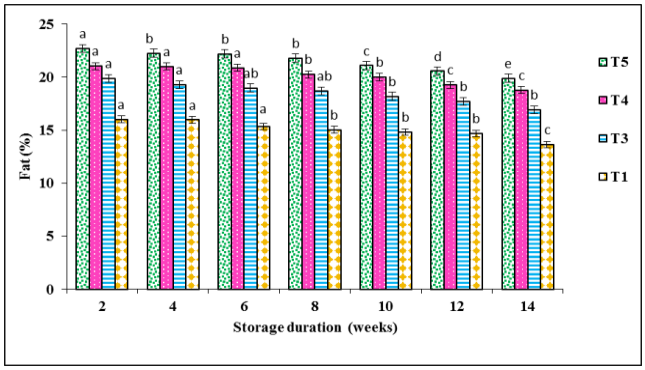
biscuit) has the very slow rate of decreasing trend than all other treatments. There was no significant difference in fiber content of T5 (40% defatted coconut flour added biscuit) from the 4th week until the end of the study period.

C. *Fat Content*

Defatted coconut flour contains a considerable amount of fat even after defatting. Fat can help leaven a product due to incorporation of air [11]. Shortening of fat or oil contribute to the tenderization of baked products through inhibition of gluten development and starch gelatinization. The changes in fat of the biscuits during storage are shown in Figure below.



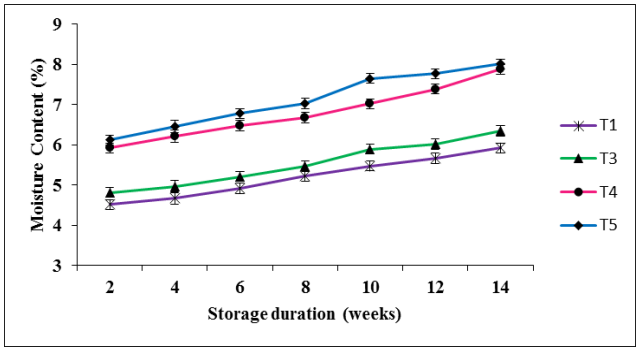
This is through a water proofing effect, possibly due to the complex with the carbohydrate and/or protein. Lipid oxidation is one of the major causes of food spoilage. It is of great economic concern to the food industry because it leads to development, in edible oil and fat containing foods, of various off flavours and off odours generally called rancid (oxidative rancidity), which render these foods less acceptable.

According to DMRT, fat decreased significantly, ($p < 0.05$) throughout the storage period. Reduction was due to the oxidation of unsaturated fatty acids with atmospheric oxygen and moisture uptake. Thereby, this will leads to oxidation reaction. In addition, oxidative reactions can reduce the nutritional quality of food. There were no significant differences in all treatments from 6th week until the end of the study period.

D. *Moisture Content*

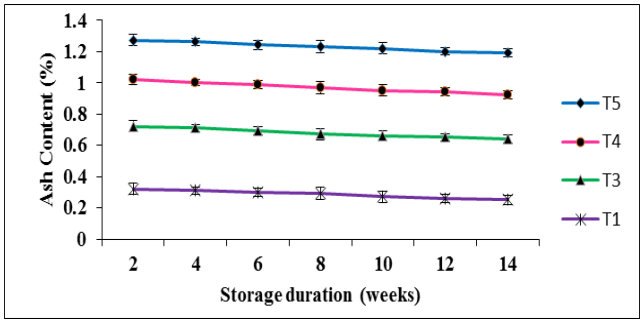
Biscuits are very hygroscopic. They typically have an equilibrium relative humidity around 30%. Therefore, in most cases they must be protected from the atmosphere to prevent or at least delay, moisture pick up. The changes in moisture content of the biscuits during storage are shown below. This is in contrast with Sindurani [12] who reported that the lower the moisture content of a product to be stored the better the shelf life of such product. But Fennema, stated that low and intermediate moisture foods, such as bakery products, the ability of proteins to bind water is critical to the acceptability of these foods.

According to DMRT, moisture content increased significantly ($p < 0.05$) throughout the storage period. T1 (100% wheat flour) and T3 (20% defatted coconut flour added biscuit) have the slow rate of increasing trend than T4 and T5. In the treatment T5, there was no significant difference from 6th to 10th week of storage period.



E. *Ash Content*

The changes in ash content of the biscuits during storage are shown in Figure below. According to DMRT, ash content decreased significantly ($p < 0.05$) through the storage period. Ash in all treatments have very little changes throughout the storage duration. Even though T3 (20% defatted coconut flour added biscuit) has the very slow rate of decreasing trend than the all other treatments and there were no significant differences in ash content of T5 throughout the storage duration.



Mineral losses may occur by heat – induce chemical reaction between reducing sugars and amino acids or proteins to form compounds that bind minerals. These browning reaction products are more resistant to digestion and hence capable of having their mineral – binding properties remain intact. Considerable amounts of some soluble minerals are also dissolved in water. This also leads to mineral loss throughout the storage period due to hygroscopic nature of the product. Likewise packaging can alter the food composition and thus influence mineral bio – availability.

F. *Sensory Analysis of Fiber Enriched Wheat-Defatted Coconut Flour Biscuits During Storage*

Organoleptic characteristics of the biscuits were slightly changed during the storage period. This may be due to the non- enzymatic browning reaction (Maillard reaction) and fat oxidation. Off-flavour development occurs during storage as a result of auto-oxidation of fats. Berger (1970) reported that moisture uptake and gas exchange were cause of off odour development in biscuits. During the storage of food, Maillard

reaction has impact on sensory qualities. The mean values of sensory attributes of stored biscuits are shown in Table.1

Table 1: Mean Values of Sensory Attributes of Biscuits following storgae

Treatments	Colour	Texture	Flavour	Overall Acceptability
T_1	6.30±0.25[a]	6.16±0.19[a]	5.8±0.29[c]	6.30±0.21[b]
T_3	6.10±0.34[a]	6.03±0.27	6.20±0.3[b]	5.20±0.23[b]
T_4	6.00±0.21[a]	6.00±0.30[a]	6.54±0.25[a]	5.23±0.21[b]
T_5	5.97±0.24[a]	5.8±0.36[b]	6.64±0.29[a]	6.12±0.26[a]

The values are means of 30 replicates ± standard error
The means with the same letters are not significantly different from each other at 5% level, based on DMRT.
The sensory qualities were analyzed in 7.0 hedonic scale using Friedman test

The 40% defatted coconut flour added biscuits (T5) has the best shelf life in nutritional and organoleptic point of view when compared to the other combinations of wheat and defatted coconut flour biscuits.

From the overall acceptance rating, the 40% defatted coconut flour added biscuits has the highest mean value and no remarkable changes in organoleptic characters were observed upto three months of storage in ambient condition of average temperature 30ºC and relative humidity of 75 - 80%, indicate that the 40% defatted coconut flour added biscuits could be stored up to three months. Similar results have been observed by [13] in their study that addition of 40% coconut flour is feasible to produce organoleptically and nutritionally acceptable biscuits.

G. Microbial Analysis

The microbial examination, in terms of aerobic plate counts (APC, CFU/g), ranged from 1.00 to 1.75. The counts were minimal and are within acceptable limits after the period of three months of storage [7]. Microorganism play a significant role in the determination of shelf life products. They are usually responsible for spoilage of many food items. A high aerobic plate count could indicate the presence mixed population of microorganisms, which may consist of spoilage types. Limits of microbial counts have been recommended in most foods to keep them safe for consumption [14].The product should however be well kept after processing in suitable packaging materials capable of preventing contamination and hence subsequent proliferation of spoilage microorganisms.

H. Shelf Life Evaluation

In this study, nutritional analysis of wheat – defatted coconut flour biscuits revealed that there were significant differences between treatments and days of storage for protein, fiber, fat, moisture and ash. However, the nutritional compositions of biscuits were changed at very slow rate during the storage period. Organoleptic characters of developed biscuits stored at room temperature did not change significantly during the storage period. After the storage period of 12 weeks, significant changes in these quality attributes were observed.

III. CONCLUSIONS

Substitution of defatted coconut flour into wheat flour biscuits is possible and based on the sensory evaluation, microbial and physico – chemical data, 40% defatted coconut flour added biscuit was selected as the best product. The biscuits made from this best combination could be stored for 12 weeks in ambient condition of average temperature and relative humidity of 75–80% without major quality deterioration.

REFERENCES

[1] Manley D. J. R. Biscuit, Cookies and Crackers Manufacturing, Manual 6: Packaging and Storing. 3rd Ed., Woodhead Publishing Limited, Cambridge, England, 1998, pp. 5. C
[2] Man and Jones. Shelf life evaluation of foods. Blackie academic professional, Chapman and Hall, Glasgow, Uk, 1994, pp. 203.
[3] Steele R. Understanding and measuring the shelf-life of food. (Woodhead Publishing Limited, Cambridge, England), 2004, pp. 50.
[4] Ooraikul B. and Stiles M.E. Modified atmosphere packaging of food. 1st Ed. (Ellies Horwooi, London), 1991, pp. 28-30.
[5] Ackermann P., Jagerstad M. and Ohlsson T. Foods and packaging materials – chemical interactions. 1st Ed., The Royal Society of Chemistry, UK, 1995, pp. 33-34.
[6] AOAC. Official Methods of Analysis, Association of Official Analytical Chemists, Washington, D.C., New York, USA, 2000.
[7] Fawole, M. O. and Oso, B. A. Laboratory manual in microbiology, 1998, 3: 158-174.
[8] Marquez, P. O. Nutritional advantages of Philippine coconut flour. Coconut Farmers Bulletin. (1979), 4: 1-7.
[9] Singh, R. P. Scientific principles of shelf life evaluation protein biscuits. Journal of Food Science and Technology. (2000).31: 117-121.
[10] Fennema, O. R. Food Chemistry. CRC press, Wisconsin, USA. (1996). 3: 157-412.
[11] Brooker, B. The role of fat in biscuits: Strategy for fat reducing products. Woodhead publishers, Cambridge, UK, (1998). pp.127-168.
[12] Sindurani, J. A. and Rajmohan, T. Effects of different levels of coconut fiber on blood glucose, serum insulin and minerals in rats. Indian Journal of Physiology and Pharmacology, (2000). 44 (1): 97-100
[13] Gunathilake, K. P. and Abeyrathne, Y. M. Incorporation of coconut flour into wheat flour noodles and evaluation of its rheological, nutritional and sensory characteristics. Journal of Food Processing and Preservation, (2008). 32: 133-142.
[14] Porter, N. N. Food science. Third Edn. AVI publishers, Cambridge, UK. (1978) 406-415.