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RESEARCH ARTICLE

PHYSICAL, CHEMICAL AND MICROBIAL PROPERTIES OF COOKIES DEVELOPED USING COCONUT PRODUCTS

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ABSTRACT

Experimental Cookies (EC) were prepared by incorporating at different levels of coconut flour, coconut sugar and VCO and compared against standard cookies (SC). Microbial, physical and chemical properties of the cookies were evaluated. With the incorporation of these coconut products, physical properties like weight, diameter, thickness, spread ratio and volume of the cookies had negligible decrease, while there was an increase in the density of the cookies. Experimental cookies had highest ash content and low moisture and peroxide value than the standard one. The Microbial count of the EC (1.33 ± 0.12 x 10^3 Cfu/g) was marginally high than SC (1.70 ± 0.10 x 10^3 Cfu/g) but lies within the acceptable limit. From the aforesaid it can be concluded that the inclusion of coconut products in the preparation of cookies does not alter the physicochemical properties and keeping quality.

INTRODUCTION

Cookie is a small, flat, sweet, baked food, usually containing flour, eggs, sugar, and either butter or cooking oil. It may include other ingredients such as raisins, oats, chocolate chips or nuts. They come in an infinite variety of sizes, shapes, texture, composition, tenderness, tastes, and colours (Pyler, 1988). Coconut is widely known as the tree of life, due to its significant contribution to human life from all of its meat, water, husk, shell, wood, leaves, spikelet, etc. Every part of the palm is utilized for the benefit of human race and its fruit particularly provides important constituent of food which is indispensable in every household (Magat, 1999).

Coconut is one of the oldest crops grown in India and presently covers 1.5 million hectares in this country with a total production of over 10,000 million nuts. Coconut flour from coconut residue, a by-product of the coconut-milk industry, contained 600 g total dietary fibre/kg (560 g insoluble and 40 g soluble fiber/kg) (Trinidad *et al,* 2001). The diet of diabetic subjects incorporated with coconut flour supplement confirmed the decreasing level of GI (Glycaemic Index) with increasing levels of coconut flour content (Trinidad *et al,* 2003). Coconut flour may play a role in controlling cholesterol and sugar levels in blood and prevention of colon cancer. Studies revealed that consumption of high fibre coconut flour increases fecal bulk (Arancon, 1999). Coconut sugar (also known as coco sugar, coconut palm sugar or coco sap sugar) is derived from the sap of cut flower buds of the coconut palm, is an organic sustainable natural sweetener. This sugar has a low glycemic index and is also a nutrient powerhouse, filled with lots of vitamins, minerals and amino acids. Consumption of coconut sap sugar helps to reduce weight and manage diabetes (Yvonee, 2012).

Out of the *twenty* amino acids that are needed for growth, repair and maintenance of body tissues, enzymes, hormones and other vital body substances, sixteen of these aminoacids are present in the coconut sap (Zello *et al,* 1995). Aside from containing *amino acids coconut sap* also contains **Inositol,** a *vitamin B complex* that the body needs in small amounts to function and stay healthy is the *highest* of all vitamins found in the *coconut sap. Inositol* is now being studied in the prevention of cancer (Vucenik and Shamsuddin, 2003). Coconut oil extracted from fresh and mature coconut without chemical treatment or any refining is known as virgin coconut oil (Marina *et al,* 2009). During recent years VCO has received much attention due to its superior aroma; flavour and potential health benefits (Villarino *et al,* 2007). VCO is rich in medium chain fatty acids that have been shown to speed up the metabolism and found to have wide application against various

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microbes such as fungi, bacteria and viruses (German and Dillard, 2004).

MATERIALS AND METHODS

Sources of Raw Materials

The ingredients used for the preparation of cookies were maida, coconut flour, cane sugar, coconut sugar, butter, virgin coconut oil, milk, baking powder, cashew nuts and raisins. Two of the ingredients namely milk and coconut was obtained fresh from investigator's farm. The remaining ingredients were purchased from the reputed departmental store in Coimbatore.

Preparation of Coconut Flour

Coconut flour was prepared from the fully matured dry coconut. The coconut endosperm after the removal of shell and paring, was shredded and the coconut gratings were grounded to extract the coconut milk. The meal remaining called the "sapal" was washed in hot water to reduce the oil content. The residue was then sundried for 48 hours and ground. The flour obtained was stored at room temperature and used for further preparations and analysis.

Formulation of cookies

Bakery products are gaining extreme popularity as processed foods which offer ready to eat convenience as well as have comparatively long shelf life. Cookies are baked products of dough with low water content, and higher amounts of sugar and shortening (Gwirtz *et al*., 2007). Two different cookies were formulated namely standard cookie (SC) and the other experimental cookie (EC). SC was prepared with maida, cane sugar, butter, baking powder, cashew nuts and raisins. EC was prepared with maida, coconut flour, cane sugar, coconut sugar, butter, VCO, milk, baking powder, cashew nuts and raisins.

Evaluation of physical properties of Cookies

Knowledge of the physico-chemical properties of food is fundamental in analyzing the characteristics of food during its processing. The study of these food properties and their responses to process conditions are necessary because they influence the treatment received during the processing and qualities of food (Rao and Das, 2003).

The following physical characteristics were analysed in the prepared cookies by following the method of Srivastava *et al*. (2012).

- Weight: The cookies were selected randomly and the weight of the cookies was measured using analytical balance
- Thickness: The thickness was measured in mm by screw gauge.
- Diameter: The diameter was measured in mm by vernier caliper.
- Spread ratio: The spread ratio was calculated as a ratio of diameter to thickness.

$$\text{Spread ratio} = \frac{\text{Diameter (mm)}}{\text{Thickness (mm)}}$$

- Volume: Volume of biscuit is defined as the area of the biscuit multiplied by thickness.

$$\text{Volume (cm}^3\text{)} = \frac{d^2 \pi T}{4}$$

T =Average thickness of biscuit (mm)
d=Diameter of biscuit (mm)

- Density: After calculating volume, density was obtained by ratio of weight of volume

$$\text{Density(g/cm}^3\text{)} = \frac{\text{Mass of sample (g)}}{\text{Volume of sample (cm}^3\text{)}}$$

Evaluation of Chemical properties of Cookies

The chemical analysis like moisture (AOAC, 1980), ash (AOAC,1980) and peroxide value (AOCS, 1990), were analysed for SC and EC on the 0^{th} day and 56^{th} day.

Microbial Count of Cookies

Microbial analysis is the term used to enumerate and identify bacteria, fungi and other microbial growth. In a food processing plant, microbiological testing is an essential factor to assure safety and quality products for the customers. Microbiological testing on various points of production is an essential quality control factor **(Gladrey, 2000).**

Microbial analysis was carried out by total plate count (TPC). Standard plating in nutrient agar was carried out. The total microbial load of the developed novel foods were determined in nutrient agar media according to the method given by Harrigan and McCance (1966). The total microbial count was analysed on the first day of preparation and then periodically every week over the storage period.

RESULTS AND DISCUSSION

Physical Properties of the Cookies

The physical parameters of cookies are commonly used parameter in objective judgment of quality. The results revealed that the incorporation of coconut flour resulted in the decrease of total weight, diameter, thickness, spread ratio and volume of the cookies (Table 1) . The weight of the SC and EC was 15g and 14g respectively. The diameter, thickness, and volume were highest in SC (49.6mm, 11.02mm, and 21.24 cm^3 respectively) while the same was found to be less in EC (42.4mm, 10.04mm, 4.22 and 14.11 cm^3 respectively). This reduction was due to the addition of coconut flour, which might have contributed to the enhanced hydration capacity of the flour. The same results were reported by Sujirtha and Mahendran (2015) on the incorporation of defatted coconut flour in wheat biscuits. Khaliduzzaman *et al*. (2010) also reported that the diameter was decreased as substitution level of potato flour increased in the baked samples and this may be due to the higher water holding capacity of potato flour.

Table 1 Physical Properties of the cookies

Parameters	SC	EC
Weight (g)	15	14
Diameter (mm)	49.6	42.4
Thickness (mm)	11.02	10.04
Spread ratio	4.50	4.22
Volume (cm^3)	21.24	14.11
Density (g/ cm^3)	0.71	0.99

Spread factor is the ratio that depends on the values of the thickness and diameter of the cookies. It is an important quality parameter, higher the spread ratio higher will be product yield. Spread ratio for SC and EC was 4.50 and 4.22 respectively, the same trend was noticed by Dhankhar (2013) who reported that control cookies made with wheat flour was found to have a spread factor of 7.58±0.07 where as for coconut cookies, it was lower (6.18±0.07). Hoojat and Zabik (1984) also showed that 20 and 30% replacement of navy bean, sesame seed flour reduced the spread factor of the whole wheat flour cookies.

Significant difference occurs in the spread potential at difference soft flour varieties (Mehri, 2009). Cookie spread rate appears to be controlled by dough viscosity (Yamazaki, 1962, Hoseney *et al*, 1988, Hoseney and Rodger, 1994; Miller *et al*, 1997). The flour components that absorb large quantities of water reduce the amount of water that is available to dissolve the sugar in the formula. Thus, initial viscosity is higher and the cookies spread less during baking (Hoseney and Rodger, 1994), this is also proved in the present result as the spread factor of EC was less than SC, since extra water was added during the preparation of dough, which could aggregate for the lower spread factor. Hoseney and Rodger (1994) had evoked highest spread ratio in the chickpea cookies, because the flour has low hydration properties. The volume of the cookies decreased (SC -21.24 cm^3, EC – 14.11 cm^3) linearly whereas, density increased (SC – 0.71 g/ cm^3, EC – 0.99 g/ cm^3) in a similar manner. This may be due to higher fiber content of the flour. The same results were recorded by Srivastava *et al*. (2012) in the cookies prepared from sweet potato flour.

Chemical Properties of the Cookies

The moisture content of SC and EC was 4.23 ± 0.06 % and 4.28 ± 0.26 % respectively on 0^{th} day (Table 2). On storage decreasing trend in both the cookies were noticed but was not significant. Significant decrease ($p \leq 0.05$) was found in SC on comparing between 0^{th} day and 56^{th} day values. No significant decrease was found in EC on storage.

Whereas, Laelago *et al*, (2015) observed moisture range of 9.66 ± 0.04 to 12.27 ± 02 in the cookies prepared from the composite flours of orange fleshed sweet potato and wheat flours. At lower moisture content the deterioration of baked product would be lowered due to reduced activity of microorganisms. Ezeama (2007) also reported that microbial proliferation was minimum at low moisture content and it confers higher shelf-life stability of the cookies. Sujirtha and Mahendran (2015) also recorded highest moisture content of 5.92 % in the wheat cookies incorporated with 50 % of coconut flour. The increase in moisture content can be attributed to the increased protein content which also increased the water binding capacity of biscuits with high levels of defatted coconut flour. Singthong *et al*. (2011) observed similar increase in moisture content with increasing levels of coconut flour.

The ash content of a food material could be used as an index of mineral constituents of the food (Sidorova *et al*., 2007). The ash content of SC (1.64 ± 0.17 %) was less than EC (1.85 ± 0.06 %) on 0^{th} and 60^{th} days (SC- 1.62 ± 0.03 %, EC - 1.83 ± 0.01 %). No significant decrease was observed between the 0^{th} and 60^{th} day. Sujirtha and Mahendran (2015) also reported that the ash content of biscuits increased from 0.35 to 1.48% with increase in the percentage of defatted coconut flour from 0 to 50% in wheat cookies. The higher ash content in EC might be due to the fact that coconut flour contained higher amounts of minerals compared to all purpose flour. The results agrees with the work of Srivastava *et al*. (2010) who also reported increased moisture and ash values with increasing percentages of defatted coconut flour substitution in wheat flour biscuits.

Peroxide value is an indicator of rancidity development during storage. Peroxide value is used to assess oxidative and hydrolytic rancidity (Kilcast and Subramaniam, 2000). The peroxide value of SC (0.04± 0 %) was significantly ($p \leq 0.01$) higher than EC (0.02± 0.01) on 0^{th} day. On storage the values increased in both the samples (SC - 0.05 ± 0.01 %, EC - 0.03 ± 0.01 %) and the peroxide values of SC ($p \leq 0.05$) was significantly higher than EC. On comparing the values of 0^{th} and 56^{th} day of SC and EC, no significant difference was observed. Use of saturated fats appear ideal from the oxidattive stability perspective. The present result proves this statement, Obasi *et al*. (2012) also reported the peroxide value of 0.21 for coconut. EC prepared with 60% of coconut oil and 40 % of butter had scored significantly less peroxide value than SC (prepared with 100 % butter) initially and also after the storage period. Fresh oils have peroxide values less than 10meq/kg (Codex Alimentarius Commission, 1982) while values above 20 indicate rancid taste and disagreeable odour (Pearson, 1976). The low peroxide values are indicative of low level of oxidative rancidity in the cookies.

Table 2 Chemical Properties of the Cookies

Parameters	0^{th} day		56^{th} day		't' Value			
	SC	EC	SC	EC	0^{th} day SC Vs EC	56^{th} Day SC Vs EC	SC 0^{th} Day Vs 56^{th} Day	EC 0^{th} Day Vs 56^{th} Day
Moisture (%)	4.23 ± 0.06	4.28 ± 0.26	4.03± 0.06	4.25 ± 0.14	0.347NS	2.551NS	4.132*	0.177NS
Ash (%)	1.64 ± 0.17	1.85 ± 0.06	1.62 ± 0.03	1.83 ± 0.01	1.970NS	10.649NS	0.163NS	0.466NS
PeroxideValue (%)	0.04± 0	0.02± 0.01	0.05 ± 0.01	0.03 ± 0.01	5.000**	2.828*	2.000NS	2.121NS

** - Significance at 1% level, *- Significance at 5% level, NS – Not Significant

In general, the oxidative stability of finished products can be attributed to a number of factors such as ingredients used in the formulation, processing method, addition of antioxidants and packaging method. Kaddour *et al*. (2006) found that the cracker made with 10 % rapeseed oil oxidized significantly more than a cracker with 0% saturated palm oil. Biscuits fortified with high oleic sunflower oil had initially high peroxide valuse (greater than 20mEq/Kg) that appeared to level off (35mEq/Kg) after 90 days of storage (Marconi *et al*, 2014). The incorporation of air into the dough during kneading may also facilitate the oxidation process. The storage temperature may also contribute to observed differences in oxidation among researchers. Calligaris *et al*. (2007) observed dramatically different rates of oxidation during the storage of cookies at different temperatures.

Microbial Count of the Cookies

Total viable count as the name suggests it is a count of the total number of living bacteria in the food. The total number of viable colonies in both the cookies did not show marked difference (Table 3). It also showed that the total colony count increased linearly with the increase of storage period. Total viable count reflects the conditions in which the food was processed, produced and stored, this count can be used to predict the shelf life or keeping quality of the product. The spoilage of many foods may be imminent when the total viable count reaches 10-100 million per gram of the product. The total microbial load of the cookies ranged from 0.23 cfu/g x 10^3 to 1.70 ± 0.10 cfu/g x 10^3. Microbial load of biscuits was in the acceptable limit for a period of 56 days from preparation. The bacterial count of all cookie samples was lower than acceptable limit of 1x10^5 CFU/g of sample.

On 0^{th} day the level in SC and EC was 0.23± 0.06 cfu/g x 10^3 and 0.13 ± 0.06 cfu/g x10^3 respectively and the difference was not significant. This result is supported by Omah and Okafor (2015) who have recorded 0.2 cfu/g x 10^2 in the cookies made from blends of millet pigeon pea composite flour and cassava cortex.

Table 3 Microbial Count of the Cookies

Days	SC Cfu/g x 10^3	EC Cfu/g x 10^3	*'t' value*
Initial	0.23 ± 0.06	0.13 ± 0.06	*2.121 NS*
7^{th} day	0.23 ± 0.06	0.13 ± 0.06	*2.121 NS*
14^{th} day	0.33 ± 0.06	0.40 ± 0.1	*1.000 NS*
21 st day	0.53 ± 0.06	0.73 ± 0.15	*2.121 NS*
28^{th} day	0.73 ± 0.15	1.00 ± 0.17	*2.000 NS*
35^{th} day	0.83 ± 0.15	1.13 ± 0.12	*2.714 NS*
42^{nd} day	0.97 ± 0.15	1.47 ± 0.12	*4.523 **
49^{th} day	1.00 ± 0.10	1.63 ± 0.21	*4.750 ***
56^{th} day	1.33 ± 0.12	1.70 ± 0.10	*4.158 **

** - Significance at 1% level, *- Significance at 5% level, NS – Not Significant

The microbial count did not increase upto on 7^{th} day as such like 0^{th} day. From 14^{th} day the count of EC increased than SC, but was not significant. On 21^{st} day the level was 0.53 ± 0.06 cfu/g x 10^3 and 0.73 ± 0.15 cfu/g x 10^3in SC and EC respectively. Significant ($p \leq 0.01$) increase in EC (1.47 ± 0.12 cfu/g x 10^3) than SC (0.97 ± 0.15 cfu/g x 10^3) was noticed on 42^{nd} day and this persisted till the end of the storage period. Addition of coconut flour, coconut sugar and VCO had its impact on the significant increase in the total viable count of EC than SC. The current study result is consistent with the findings reported by Emmanuel *et al*. (2012) who indicate that the total microbial load was 9.0x10^2 to1.5x10^3 cfu/g in the cookies produced from wheat flour fortified with *Termitomyces robustus* and spiced with curry leaves.

Seevaratnam *et al*. (2012) reported that the bacterial count of the cookies incorporated with 20 % potato flour was 3x10^3 cfu/g, 4.5x10^3 cfu/g and 6.5x10^3 cfu/g respectively for fresh, 30 days and 60 days of storage.

CONCLUSION

The results indicate that coconut products can be used successfully for the preparation of cookies which have almost possess the same physicochemical properties and microbial quality as that of standard ones. These cookies add variety and value. The results obtained could be very valuable in decision making for manufacturers to utilise coconut products as an alternative or supplement to cereal flours for the production of various bakery foods and also it would be of economic importance to exploit the local farm produce.

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