Effect of fortification of fresh cow milk with coconut milk on the proximate composition and yield of warankashi, a traditional cheese

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Summary

Cheese is a concentrated dairy product produced by acid or rennet coagulation or curdling of milk, stirring and heating the curd, draining off the whey, collecting and pressing the curd. The effect of partial substitution of fresh cow milk with coconut milk on the yield and proximate composition of cheese was examined. Extracted coconut milk was mixed with fresh raw cow milk at varying proportions of 5%: 95%, 10%: 90%, 15%: 85%, 20%: 80%, 25%:75%, 70%: 30% and the control (0%:100%) to produce cheese. The control and the partially substituted cheeses were stored in a refrigerator and examined for sensory quality, percentage yield, total titrable acidity, and proximate analysis. The yield of cheese showed significant ($p < 0.05$) decrease from 26.71% (control sample) to 13.55% as the level of coconut milk increased. The total titrable acidity of cheese was found to be between the ranges of 0.20% - 0.29% which displayed a significant increase from 0.20% - 0.29%. The protein content of the cow-coconut cheese blends showed a significant difference ($p<0.05$) and an increase of 14.05%-15.33% (at 5%-30% substitution of coconut milk), with the control sample having 13.75%. There was also an increase in fat content from 9.20% - 9.64% (5% - 30% substitution of coconut milk, with the control sample having 8.94%. There was a decrease in the carbohydrate content of the cheese blends which ranged between 8.23% -2.82%, with the control sample having 9.60%. There was a significant decrease ($p<0.05$) in the ash content of the cow-coconut cheese blends, with the control sample having 1.02%. Significant difference ($p<0.05$) was observed in the colour, aroma, taste, texture, and overall acceptability as influenced by varying proportions of added coconut milk. The blend with 5% coconut milk and 95% cow milk was most acceptable by panellists. The work showed the potential of coconut as an alternative source of milk in cheese making with improved nutritional value and consumer acceptability.

Keywords: coconut milk, cheese, proximate, yield, *warankashi*

Introduction

Milk, as an agricultural product, is extracted from mammals during or soon after pregnancy and is used as food for humans. Cheese is a concentrated dairy commodity produced by acid or rennet coagulation or curdling milk, stirring and heating the curd, draining off the whey, collecting and pressing the curd. The cheese is ripened, cured, or aged to develop the flavour and texture. According to Bodyfelt et al. (1988) cheese is a dairy product made by coagulating either whole milk, part-skim (low fat) milk, skim milk, or cream by removing much of the liquid portion while retaining the coagulum and the entrapped milk solids. The Fulanis of northern Nigeria are traditionally cattle rearers and they have access to fresh milk from *Zebu Bos indicus* cattle. Wara cheese making is thought to have started in this region, and as a result of the nomadic lifestyle of the Fulanis has spread to other states of Nigeria like Kwara, Oyo, Ogun, Ondo, and the Benin Republic (Bamidele, 2006). Cheese is an excellent source of protein, fat and minerals such as calcium, iron and phosphorus, vitamins and essential amino acids, and is therefore an important food in the diet of both young and old people (Oladipo and Jadesimi, 2012).

Coconut (*Cocos nucifers* of the *Family Palmae*) grows extensively in Nigeria and is eaten as a snack usually for pleasure. Coconut is a fruit rich in fiber (aids digestibility), iron, and other minerals. Coconut also serves as an excellent source of raw materials for the development of dairy-like products. Coconut milk is the liquid that comes from the grated meat of a brown coconut (it is different from coconut water). The colour and rich taste of coconut milk can be attributed to the high oil content. Most of the fat is saturated fat. Coconut milk has the following nutritional properties; protein (3%), fat (17% - 24%), and carbohydrate (2%). It has no cholesterol, contains many vitamins, minerals and electrolytes, including potassium, calcium and chloride (Amarasiri and Dissanayake, 2006). It has many uses, most of which build up the immune and the body's defence system (Mensink et al., 2003). It contains a large proportion of lauric acid, a saturated fat that raises blood cholesterol levels by increasing the amount of high-density lipoprotein cholesterol, which is also found in significant amounts in breast

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milk and sebaceous gland secretions (Amarasiri and Dissanayake, 2006). This may create a more favourable blood cholesterol profile, though it is unclear if coconut oil may promote atherosclerosis through other pathways (Mensink et al., 2003).

Coconut milk is lactose free, unlike cow milk, and can be used as a milk substitute by those with lactose intolerance. Therefore, this research study is aimed at increasing the utilization of coconut milk in cheese making and at improving the nutritional composition of cheese.

Materials and methods

Material Collection and Preparation

Sodom apple leaves (*Calotropis procera*) and fresh cow milk were obtained from a nomadic settlement located within Oke-oyi (precisely Centu) Local Government Area of Ilorin, Kwara State, Nigeria. The fresh cow milk was collected from a healthy cow aseptically, packaged in a sterile white container, and placed in a cooler containing ice crystal. This helped to prevent postharvest contamination and the increase in temperature during the long transportation. The coconut was purchased from a local market in Ilorin. The production process was carried out carefully using the method described by Igyor et al. (2006), which is a traditional processing method.

Production of Coconut Milk

A whole coconut was purchased, shelled, and shredded using a traditional coconut grater. Coconut milk was produced by mixing the shredded pulp with an equal weight of warm distilled water (60°C) in a blender, filtered through a double-layered cheese cloth, and manually squeezed with a twisting motion to extract most of the milk. The extracted emulsion was pasteurized and stored at 30°C before the production of cheese and used within 24 hours of production.

Production of Cheese (Warankashi)

The portion of the sieved milk for *warankashi* production from both the cow and the coconut was measured. The variation in the measurement was done according to the method described by Igyor et al. (2006). Cheese samples were produced from 1000 ml of cow milk with added coconut milk formulated by partial substitution of cow milk with coconut milk at varying proportions, to create a range of 5:95; 10:90; 15:85; 20:80; 25:75; 30:70 (v/v). The hundred percent (100%) cow milk *warankashi* was produced

from 1000 ml of fresh cow milk and used as the control sample. The sodom apple leaves were used as a coagulant. They were washed and pounded using a mortar and pestle. 15 g of the pounded sodom apple leaf was added to each of the milk blends.

The method of Ashaye et al. (2006) with some modifications was used to produce the cheese. Fresh cow milk with coconut milk blend was transferred into a metal pot. The metal pot was then placed over a slow burning fire and heated to a temperature of 50 °C. 15 g of pounded *Calotropis procera* leaves was added to the warmed milk. The milk was heated slowly. The metal pot was removed from the fire to cool to about 40 °C, and the leaves were sieved out. The metal pot was then placed on a slow burning stove to boil until it reached boiling point. The milk was kept at the boiling point until it coagulated and there was a visible separation of curds and whey. The curds were then scooped using a scooping spoon into a small set of small raffia baskets (akpere-wara) placed over a container for whey collection. The raffia basket helped to give the final cheese product with a desired shape. After a few minutes, the curd was formed and placed in a clean container containing cool water.

Determination of percentage yield

The yield was determined by a method described by Igyor et al. (2006). The yield of *warankashi* from the cow milk-coconut milk blends/mix and the whole cow milk was determined by the calculation as follows:

$$\text{Yield of } warankashi \ (\%) = X2/X1 \ x \ 100/1$$

where: X1 = volume (ml) of cow milk-coconut milk or whole cow milk used
X2 = weight (g) of *warankashi* (either from blends or whole cow milk) produced
(assume 1 gm =1 ml)

Proximate Analysis

The standard method of the AOAC (2000) was used for the analysis of protein percentage, crude fat, ash content, crude fiber, and moisture content. Moisture content was determined after drying at 103 ºC until a constant weight was attained. Protein was determined by the Kjeldahl method (N x 5.84), crude fat was extracted with petroleum ether using Soxhlet apparatus (gravimetric method), ash (gravimetric method), while total carbohydrate quantity was determined by the differences: % carbohydrate = 100- (% protein + % fat + % ash + % crude fiber + % moisture).

Total Titratable Acidity

It was determined using the AOAC (2000) method. Ten grams of the sample was dissolved in 30 ml of distilled water in a beaker and stirred. The mixture was then filtered into a 100ml standard volumetric flask. The filtrate was made up to 100 ml. 10 ml of the filtrate was pipetted into a beaker and 1 drop of phenolphthalein was added. The mixture was then titrated against the standard 0.01 N sodium hydroxide solution until a light pink colour was attained. The reading of the burette was recorded. This was done in duplicates.

Calculation:

$$\frac{N\ (NaOH) \times titre\ value \times lactic\ acid\ value \times dilution\ factor \times 100}{10}$$

where: N = normality of NaOH (0.01)
    Lactic acid value = 0.09
    Dilution factor = 10

Sensory Evaluation

Sensory evaluation was conducted using a 7-point hedonic scale and a semi-trained panel consisting of 20 members familiar with the consumption of *warankashi*. The panellists were instructed to evaluate the coded samples for colour, taste, texture, aroma, and overall acceptability. Each sensory attribute was rated on a 7-point hedonic scale (1 = like extremely and 7 = dislike extremely) (Iwe, 2007).

Statistical Analysis

SPSS 16.0 was used to statistically analyze the data obtained from the study. Results obtained are triplicate determinations and were subjected to an analysis of variance to determine the significant differences among the samples, and the means were separated using the Duncan test.

Results and discussion

The percentage yield and total titrable acidity of cheese with added coconut milk were presented in Table 1. Results showed a significant ($p < 0.05$) decrease in percentage yield of cheese samples, from 26.71% the control sample (100% cow milk) to 13.55% for the cheese produced with 70:30 proportion of cow-coconut mix. This result was not in agreement with the findings of Adedokun et al. (2013) who reported an increase in percentage yield of cheese as the inclusion percentage of bambara milk increased in the cheese (28.05% - 41.11% for 100% cow cheese and cheese with 50% bambara milk supplementation). However, Igyor et al. (2006) reported a decline in the percentage of cheese yield as the percentage of soymilk inclusion increased in cheese (30.50% -15.50% for 100% cow cheese and cheese with 75% soymilk supplementation). Also, Fashakin and Unokiwedi (1992) reported that the percentage yield remained relatively constant with levels of soy substitution. These findings indicate that the percentage yield may depend on the level of available protein for curdling by enzyme or acid. However, Fox (1993) stated that the principles of cheese making involve the removal of water from milk with a consequent six-to tenfold concentration of the protein, fat, minerals, and vitamins by the formation of a protein coagulum which further shrinks to expel whey. Therefore, the decline in percentage yield in this study can be attributed to the added coconut milk which shows that coconut milk has a partial potential to be used in the production of cheese.

The Total Titrable Acidity (TTA) was found to be between 0.20% and 0.29% (Table 1), although Belewu et al. (2006) recorded a TTA of 0.15% for coconut milk. The increase in acidity could be attributed to the increase in inclusion levels of coconut milk.

Table 1. Percentage yield and total titrable acidity of *warankashi*

Cheese blends cow-coconut	Yield (%)	TTA (%)
C_{100}	26.71[a]	0.20[c]
$C_{95}C_5$	26.54[b]	0.21[c]
$C_{90}C_{10}$	24.94[c]	0.23[bc]
$C_{85}C_{15}$	21.16[d]	0.25[abc]
$C_{80}C_{20}$	18.28[e]	0.26[abc]
$C_{75}C_{25}$	15.50[f]	0.28[ab]
$C_{70}C_{30}$	13.55[g]	0.29[a]

In each of the columns, any means not followed by the same superscripts are significantly different ($p < 0.05$).
Means are values of triplicate determinations.

From the proximate analysis, there was a significant difference ($p<0.05$) in all the parameters evaluated (Table 2). The significant differences observed may be due to the coconut milk added at varying proportions to the fresh cow milk during cheese making. There was an increase in moisture content of cow/coconut cheese blends as the level of coconut milk increased. This was observed to be within the range of 66.69% and 71.86%. 100% cow milk cheese (C_{100}) had the lowest level of moisture content, while 70% cow milk - 30% coconut milk had the highest level of moisture. This result showed that the added coconut milk had higher moisture content.

Table 2. Proximate composition of cow/ cow-coconut *warankashi*

Cheese blends cow-coconut	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	CHO (%)
C_{100}	66.69[g]	13.75[e]	8.94[g]	0.00[a]	1.02[ab]	9.60[a]
$C_{95}C_5$	67.64[e]	14.05[d]	9.20[f]	0.00[a]	0.88[a]	8.23[b]
$C_{90}C_{10}$	68.40[d]	14.25[d]	9.30[e]	0.01[a]	0.80[ab]	7.24[c]
$C_{85}C_{15}$	69.92[d]	14.43[c]	9.40[d]	0.01[a]	0.71[b]	6.24[d]
$C_{80}C_{20}$	70.30[c]	14.60[b]	9.48[c]	0.02[a]	0.59[b]	5.01[e]
$C_{75}C_{25}$	71.25[bc]	15.07[b]	9.54[b]	0.03[a]	0.42[b]	3.69[f]
$C_{70}C_{30}$	71.86[a]	15.33[a]	9.64[a]	0.03[a]	0.32[b]	2.82[g]

In each of the columns, any means not followed by the same superscripts are significantly different ($p<0.05$).
Means are values of triplicate determinations.
CHO - carbohydrate

The protein content in cow/cow-coconut cheese blends (as shown in Table 2) ranged from 13.75%-15.33%. This implies that 100% cow milk cheese (C_{100}) had the lowest level of crude protein, while 70% cow milk and 30% coconut milk had the highest level of crude protein content. The cow-coconut cheese blend at 5% proportion had a protein content of 14.05%. This result implies that there was an increase in the level of protein content as the level of coconut milk increased. This can be attributed to the high digestible crude protein content of coconut milk with 3.35% - 7.87% of crude protein (Belewu et al., 2006). Also, this result shows that a vegetable source of protein (such as coconut milk) should be encouraged, as its consumption would help eliminate protein deficiencies and it is also a cheaper source when compared to 100% whole milk cheese (Adedokun et al., 2013).

The fat content of cow-coconut cheese blends differed from that of whole cow cheese blend. The control sample had the lowest fat content of 8.94%. The 5% - 30% substitution ranged between 9.20% - 9.64% respectively. The variation was found to be significantly different ($p<0.05$). This may be partly due to the varying proportions of coconut milk used in the production and partly due to the high fat content of coconut milk. Coconut milk is high in saturated fatty acids, particularly lauric acid (Amarasiri and Dissanayake, 2006). Significantly, fat is important as a source of energy in the human body (Onyeka, 2008).

The ash content in foodstuff is a measure of mineral elements in food. The ash content of the cheese samples varied significantly ($p<0.05$) and decreased among the cheese samples with increasing proportion of coconut milk. The control sample had 1.02%, while in the cheese with added coconut milk it decreased from 0.88% - 0.32% (5% and 30% proportions of added coconut milk respectively). Uaboi-Egbenni et al. (2010) reported 0.6% ash content for a fermented cheese sample.

Total carbohydrate content of the cheese samples ranged from 8.23% - 2.83% among samples with added coconut. The control sample had a value of 9.60%. This result indicates that there is a significant difference ($p<0.05$) among the samples and a decrease in the carbohydrate content of the cheese samples. Adedokun et al. (2013) recorded an increase in the total carbohydrate content (13.82% - 23.81%) as the bambara milk substitution increased.

The mean sensory scores for cheese samples produced with varying proportions of added coconut milk were shown in Table 3. There was no significant difference in the colour and taste of 100% cow milk and 75% -25% cow-coconut cheese blend. There was a significant difference in the colour and taste of the 70% - 30% cow-coconut cheese blend. There was a significant difference in the texture of the cow/ cow-coconut cheese blends. The aroma was very acceptable to the panellists. There was a significant difference in the overall acceptability of the cow/cow-coconut cheese blend. The 100% cow milk cheese and 95% cow milk, 5% coconut cheese had the highest overall acceptability. This was followed by the 90% cow milk and 10% coconut milk cheese blend. Adedokun et al. (2013) also reported that there were significant differences in aroma, taste and texture and no significant difference in the colour and overall acceptability of cow-bambara cheese blends.

Table 3. Mean scores of cow/cow-coconut *warankashi*

Samples	Colour	Taste	Texture	Aroma	Overall acceptability
C_{100}	2.20^c	1.90^c	2.20^c	1.80^b	1.90^d
$C_{95}C_5$	1.70^c	2.40^c	2.30^c	2.30^{ab}	2.20^{cd}
$C_{90}C_{10}$	2.50^{bc}	2.80^c	3.00^{ab}	1.90^b	2.70^{bcd}
$C_{85}C_{15}$	2.60^{bc}	3.30^{bc}	3.70^b	3.30^a	3.60^b
$C_{80}C_{20}$	3.50^b	2.80^c	3.20^{bc}	2.50^{ab}	3.40^{bc}
$C_{75}C_{25}$	2.70^{bc}	4.30^{ab}	2.80^{bc}	2.30^{ab}	3.00^{bc}
$C_{70}C_{30}$	4.70^a	$5.10a$	5.40^a	2.80^{ab}	4.90^a

In each of the columns, any means not followed by the same superscripts are significantly different ($p<0.05$).
Means are values of triplicate determinations.

Conclusions

The results from this study show that there was an increase in the protein and fat content of cheese as the inclusion level of coconut milk increased. The indication from this study therefore showed the possibility of using a milk analogue from a vegetable source, such as coconut, in cheese production. The nutritional value discovered while producing a cheese from cow/cow-coconut milk mix will improve the nutritional well-being of the populace from Nigeria and other developing countries. In conclusion, coconut milk has the potential to be used as a source of raw material in the production of cheese. Cow-coconut cheese blends (95% cow milk - 5% coconut milk and 90% cow-10% coconut milk) were very acceptable to panellists; therefore the inclusion of 5% or 10% of coconut milk should be encouraged in the production of cheese. The addition of coconut milk also increased the flavour and aroma of the cheese.

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