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Lime and Mango Juice as Coagulants for Soft Cheese Made from Fresh or Reconstituted Milk

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Abstract
In order to simplify the cheese-making process and find suitable alternatives to sodom apple as coagulant, cheese was prepared from fresh and reconstituted milk using lime and mango juice as coagulants. Treatments correspond to fresh milk coagulated with lime (FML), reconstituted milk coagulated with lime (RML), fresh milk coagulated with mango (FMM), reconstituted milk coagulated with mango (RMM). Chemical composition of cheese varied significantly across the treatments. Total solids was 49.9, 43.4, 49.6 and 42.1%; protein was 20.6, 18.1, 21.6 and18.9%; while fat content was 22.4, 19.7, 21.6 and 17.9% for FML, RML, FMM and RMM respectively. Protein and fat content of cheese made from fresh milk was higher than that from reconstituted milk. Mango-precipitated cheese had higher protein than lime-precipitated cheese while lime-precipitated cheese had higher fat content than mango-precipitated cheese. Cheese yield varied from 11- 16% with lime-precipitated cheese having higher yields than mango-precipitated cheese, and fresh milk yielding more cheese than reconstituted milk. Acceptability scores were 7.1, 7.1, 7.1 and 6.6 for FML, RML, FMM and RMM respectively on a scale of 1-9. Except for RMM which had a significantly lower score, there were no significant differences in acceptability for FML, RML and FMM. When compared with *wara* cheese purchased from the open market, lime and mango-precipitated cheese generally had better consumer acceptance than *wara* (acceptability score of 6.7). These results show that lime and mango juice can serve as suitable alternatives to sodom apple juice as coagulants for fresh cheese. Reconstituted milk can also be used for making cheese where availability of fresh milk is limited.
Keywords: fresh cheese, coagulants, lime, mango, milk

1. Introduction

Milk plays an important role in the nutrition and development of human beings. All nutrients, including vitamins and minerals, considered essential for growth and maintenance of good health are found in milk (O'Connor and Tripathi, 1991). In view of its nutritional importance, milk or its products should form at least part of the daily diet for humans, particularly the young and growing. A major constraint to the regular consumption of fresh milk is its very short shelf life. Cheese provides an opportunity to extend the shelf life of milk and preserve its valuable nutrients in a concentrated form (Law and Tamime, 2010).

Cheese is a dairy product obtained by coagulating milk and removing much of the liquid whey (Bodyfelt et al, 1988). Cheese is an excellent source of protein, fat, calcium, phosphorus, vitamins and essential amino acids and forms an important part of the diet for both young and old people (Adegoke *et al*., 1992). Although cheese-making is not properly documented in Africa, it is estimated that about one-third of the total milk volume is used for this purpose (FAO, 2002). The primary purpose of coagulants in cheese-making is to convert liquid milk into cheese curds (Green, 1984), however they also play important roles in the development of texture and flavour in the cheese (Law, 1987).

The West African soft cheese, *wara*, is an important component of the diet among the nomadic Fulani of Nigeria and a much cherished delicacy among the urban and peri-urban dwellers of southwestern Nigeria. The common coagulant used in making soft cheese in these parts is the vegetable rennet obtained from the leaf or stem juice of *Calotropis procera* (Omotosho et *al*., 2011). Although cheese made from this coagulant is widely accepted, the process is rather cumbersome. Soft cheese can also be precipitated from milk using organic acids obtained from lemon and other fruit juices. In Nigeria, lime and mango fruits are more readily available; hence the juice from these fruits is appropriate as alternative coagulants for local cheese production. The aim of this study therefore, was to evaluate the yield, composition and sensory properties of soft cheese precipitated with lime or mango juice from either fresh or reconstituted milk.

2. Materials and Methods

The experiment was conducted at the Dairy Unit of Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. Raw milk was collected from Sokoto Gudali cows at the Dairy Unit while reconstituted milk was prepared by mixing 1kg of milk powder into 8L of clean water.

Preparation of juice extracts

The lime fruits used for the study were sourced from an open market in Ibadan while unripe mangos were plucked from a tree within the University campus. Washed lime fruits were cut into two, squeezed and filtered

through a muslin cloth to obtain the juice. Washed unripe mango fruits were peeled to obtain the pulp, cut into small pieces and blended using an electric blender. The pulp was squeezed and filtered through a muslin cloth into a labeled bottle.

Preparation of cheese

Raw or reconstituted milk (1L each) was placed inside four stainless steel pots. Each of the milk was heated on a low intensity stove with intermittent stirring to boiling point at 82°C for approximately 20 minutes. Lime or mango juice was added at the rate of 25ml to 1L of milk. Heating of milk continued until curds were formed inside the pots. The pots were removed from the heat source, cooled inside a water bath for 15 minutes and drained through a 0.2mm sieve to remove the whey. The separated curds were wrapped inside a muslin cloth and pressed with a 500g steel weight for 45 minutes for further removal of whey. The weight of cheese produced from 1L of fresh or reconstituted milk with different coagulants was recorded.

Chemical composition and sensory evaluation

The chemical composition of the milk and cheese produced from fresh and reconstituted milk with lime or mango juice extract was determined using the methods of AOAC (2005). The sensory scores of cheese produced from fresh or reconstituted milk using lime and mango juice as coagulants were determined using the method of Iwe (2002). The cheese was assessed for aroma, colour, taste, texture and general acceptability using a nine-point hedonic scale ranging from 9 (highest score) to 1 (lowest score). Standard Nigerian soft cheese (*wara*) was purchased from the open market and used as control during the sensory evaluation.

Statistical analysis

The experimental design used in this study was the completely randomized design. All data obtained were subjected to analysis of variance and significant means were separated by Duncan's multiple range tests using the procedures of SAS (1995).

3. Results and Discussions

The chemical composition of fresh milk, reconstituted milk and cheese produced using lime and mango juice as coagulants is shown in Table 1.

Table 1: Composition of milk and soft cheese produced from fresh and reconstituted milk using lime and mango juice as coagulant

Parameters	Fresh milk	Reconstituted milk	Cheese				SEM
			FML	RML	FMM	RMM	
Total solids, %	12.81	11.40	49.94^{a}	43.42^{b}	49.57^{a}	42.06^{b}	0.64
Protein, %	3.60	3.30	20.60^{b}	18.10^{c}	21.60^{a}	18.90^{c}	0.18
Fat, %	3.10	2.80	22.40^{a}	19.70^{b}	21.60^{a}	17.90^{c}	0.47
Ash, %	0.60	0.70	2.33^{ab}	2.20^{ab}	2.63^{a}	2.02^{b}	0.10
Lactose, %	5.51	4.60	4.61^{a}	3.42^{bc}	3.74^{b}	3.24^{c}	0.09
pH	6.60	7.10	4.50^{b}	4.70^{ab}	5.00^{a}	5.10^{a}	0.11
Specific gravity	1.033	1.010	1.018^{b}	0.974^{c}	1.219^{a}	0.884^{d}	0.03

abcd: means with different superscripts within the same row are significantly different ($p<0.05$). FML: fresh milk with lime juice; RML: reconstituted milk with lime juice; FMM: fresh milk with mango juice; RMM: reconstituted milk with mango juice.

The protein, fat, lactose and total solids were slightly lower in reconstituted milk than fresh milk. The chemical composition of fresh milk used in this study was similar to that reported for Zebu cattle in Nigeria (Ndubueze et al., 2006; Adesina, 2012; Olorunnisomo, 2013) while chemical composition of reconstituted milk was similar to that reported by Olorunnisomo and Ibhaze (2010). The total solids in cheese produced from the different milks and coagulants varied from 42.06 - 49.94 %; protein,18.10 – 21.60%; fat,17.90- 22.40%; ash, 2.02 – 2.63%; and lactose, 3.24- 4.61%.

The total solids, protein, fat and lactose content was generally higher in cheese made from fresh milk than cheese from reconstituted milk. This is a reflection of the chemical composition of the initial milk from which the cheese was made. As earlier noted, these components were higher in fresh milk than reconstituted milk in this study. Although the total solids content of lime-coagulated cheese was higher than mango-coagulated cheese, a closer look shows that mango juice incorporated more of the milk protein in the cheese than lime juice while lime juice incorporated more of the milk fat in cheese than mango juice. Chemical composition of the milk and cheese formed also shows that protein and fat in milk were concentrated in the cheese while the opposite was true for lactose which was higher in the milk than the cheese. This was due to the occlusion of fat and

concentration of protein in the milk to form the cheese mass whereas a significant part of the lactose in milk was lost through the whey (Law and Tamime, 2010).

The cheese yield and coagulation time for cheese precipitated by lime or mango juice is presented in Table 2. The cheese yield obtained in this study varied from 11-16% and is much lower than 23-42% earlier obtained (Olorunnisomo and Ikpinyang, 2012) with soft cheese precipitated with different coagulants. This was due to the additional removal of whey from cheese made in this study by pressing to produce a semi-soft cheese. The cheese yield in lime-precipitated cheese was higher than cheese precipitated with mango juice. This is contrary to earlier results by Olorunnisomo and Ikpinyang (2012) where cheese precipitated with mango juice had higher yield than cheese precipitated with lime juice. The reason for this disparity in results is not known.

Table 2: Coagulation time and cheese yield as affected by milk type and coagulant

Parameter	FML	RML	FMM	RMM	SEM
Weight of milk (g)	1000	1000	1000	1000	-
Volume of coagulant (ml)	25	25	25	25	-
Coagulation time (min)	13	14	13	14	0.11
Cheese weight (g)	160^{a}	140^{b}	140^{b}	110^{c}	0.93
Cheese yield (%)	16^{a}	14^{b}	14^{b}	11^{c}	0.10

abc: means with different superscripts within the same row are significantly different ($p< 0.05$). FML: fresh milk with lime juice; RML: reconstituted milk with lime juice; FMM: fresh milk with mango juice; RMM: reconstituted milk with mango juice.

On the other hand, yield of cheese made from fresh milk was higher than yield from reconstituted milk. This is related to the higher protein and fat content of fresh milk compared to reconstituted milk. Fat and protein content of milk play a very significant role in yield of cheese (Law and Tamime, 2010). There were no significant differences in coagulation time between cheese precipitated with either lime or mango juice, and cheese from fresh or reconstituted milk.

Table 3 shows the sensory properties of cheese produced from fresh and reconstituted milk using lime and mango juice as coagulants. The aroma and taste of cheese from fresh milk were judged by panelists to be better than cheese from reconstituted milk, whereas, the colour, texture and overall acceptability of cheese from either fresh or reconstituted milk did not follow a well defined trend. The aroma, colour and taste of lime-coagulated cheese were judged to be better than mango-coagulated cheese. Although the texture of mango-coagulated fresh milk was judged to be better than lime-coagulated fresh milk, texture of mango or lime-coagulated reconstituted milk did not differ significantly ($p> 0.05$) from each other.

Table 3: Sensory properties of cheese produced from fresh and reconstituted milk using lime and mango juice as coagulant

Parameters	FML	RML	FMM	RMM	Control
Aroma	7.4^{a}	6.6^{c}	7.0^{b}	6.4^{c}	6.2^{c}
Colour	7.2^{b}	7.6^{a}	6.4^{c}	6.4^{c}	7.5^{a}
Taste	7.6^{a}	6.6^{b}	7.4^{a}	5.8^{c}	7.4^{a}
Texture	6.2^{b}	7.6^{a}	7.6^{a}	7.6^{a}	5.6^{c}
Overall acceptability	7.1^{a}	7.1^{a}	7.1^{a}	6.6^{b}	6.7^{b}

abc: means with different superscripts within the same row are significantly different ($p<0.05$). FML: fresh milk with lime juice; RML: reconstituted milk with lime juice; FMM: fresh milk with mango juice; RMM: reconstituted milk with mango juice

Overall acceptability of cheese shows that lime-coagulated fresh milk had equal acceptance with mango-coagulated fresh milk while lime-coagulated reconstituted milk had better acceptance than mango-coagulated reconstituted milk. When compared with control which was normal Nigerian soft cheese (*wara*) purchased from the open market, cheese precipitated with lime or mango juice generally had better acceptance than *wara* cheese. This is contrary to earlier results obtained by Olorunnisomo and Ikpinyang (2012) where acceptability of sodom apple-coagulated cheese (*wara*) was higher that of lime or mango-coagulated milk. The reason for this disparity is not fully understood but the harder consistency of cheese coagulated with lime or mango juice in this study may have positive influence on its consumer acceptance. There is need to further investigate the effect of consistency and degree of hardness on consumer acceptance of fresh type cheese in Nigeria.

5. Conclusion

This study revealed that cheese produced from fresh and reconstituted milk with lime or mango juice as coagulants showed significant differences in their chemical composition and cheese yield. Except for reconstituted milk coagulated with mango juice which had a significantly lower acceptability, cheese precipitated with lime or mango juice had similar consumer acceptance in this study. Since coagulation of cheese with lime or mango juice is less cumbersome and had reasonable consumer acceptance, they are recommended as suitable

alternatives to sodom apple-precipitated cheese. In the absence of sufficient quantities of fresh milk, cheese could also be obtained from reconstituted milk powder.

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