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EVALUATION OF NUTRIENT COMPOSITION OF SOFT ('UNRIPE') CHEESE-'WARANKASHI' PRODUCED WITH PARTIAL INCORPORATION OF COCOA POWDER

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ABSTRACT

Purpose: To investigate the nutrient composition of Cheese produced with partial incorporation of cocoa powder into cow-milk.

Methodology: Cocoa powder was first made into solution. Fresh Cow milk obtained from Nomadic Fulani men and cocoa powder solution were mixed at ratios (90:10, 80:20, 70:30 and 60:40 v/v) while whole cow milk served as reference. Soft cheeses were produced using standard local method. Nutrient composition of the cheese samples was evaluated. Data obtained were analysed using SPSS 17.0 version.

Findings: Increase in proportion of cocoa powder solution in cheese caused significant ($p < 0.05$) changes in its nutrient. Protein, crude fibre and vitamin A increased from 8.90–12.61%, 0.76–1.01% and 169.00–204.00 mg/100 g, respectively. Fat declined from 7.19% to 5.94%. Some minerals also increased.

Practical implications: Possibility of cheese making with cocoa substitution to give improved nutritional values and reduced fat was revealed.

Value: Nutritional well-being of the populace from Nigerians who consume 'warankashi' will improve.

Keywords: cheese; 'warankashi'; cocoa powder; protein; cow milk; fat.

INTRODUCTION

Cocoa beans are derived from the fruit of the plant *Theobroma cacao L*. In Nigeria, dry cocoa beans is majorly exported as a foreign exchange earner, while a small percentage of cocoa bean serve as raw materials for cocoa powder, cocoa butter and chocolate products (Adeyeye et al., 2010).

Cocoa as a food ingredient is fast becoming very popular in the food and confection industry worldwide. It is available in a wide variety of forms, colours and flavours and is used in numerous applications (Borchers et al., 2000). A good quality cocoa powder should be relatively free flowing, stable and uniform in colour and flavour of good microbiological quality, and easy to handle by the user (Vu et al., 2003). Moreover, a range of other characteristics such as pH, fineness, fat content, wettability, solubility and dispersibility, define the powder and have an important impact on the end product for which the cocoa is used (De Muijuck, 2005). The nutritional quality of cocoa products are determined largely by the chemical composition of the cocoa powder which is dependent on the quantum of proteins, carbohydrates, fats, minerals and phytochemicals in the cocoa products and the corresponding digestibility coefficient (Belscak et al., 2009).

Cocoa bean as well as cocoa derived products, also present a rich source of phytonutrients, particularly catechins and procyanidins (Lecumberri et al., 2007). The total poly-phenol content of the bean is estimated to be 6–8% by weight of the dry bean (Wollgast and Anklam, 2000).

Cocoa polyphenols have been reported in many studies as bioactive compounds, with antioxidant, antiradical and anticarcinogenic properties (Counet et al., 2006).

Nowadays, consumers are more concerned with the nutritional status of food stuffs and considering that cocoa powder and chocolate are extremely rich sources of many essential nutrients and phyto-chemicals that can contribute to a healthy diet, Lecumberri et al. (2007) highlight renewed interest in such products.

Cheese is a food derived from milk that is produced in a wide range of flavours, textures and forms by coagulation of the milk protein casein. It comprises protein and fat from milk, usually the milk of cows, buffalo, goats or sheep (Igyor et al., 2006). The primary objective of cheese manufacturing originally was to extend the shelf life and conserve the nutritious components of milk. According to Ramkant (2006) cheese is a product that is made from the Curd obtained from milk by coagulating

the casein with the help of rennet or similar enzymes in the presence of lactic acid microorganism. Fox et al. (2000) defined cheese as the fresh or ripe and product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, cream or partly skimmed milk, butter milk or a mixture of these products, it can also be made from the milk of cows, sheep, goats and camels or mixture of two of those (Herrington, 2000). In many tropical region of Africa (except east Africa) the production of milk and milk product are limited scarce and expensive (Fashakin and Umokiwedi, 1992) and the objectives of cheese making are to obtain the optimum cheese composition with respect to moisture, Acidity, pH, fat, protein and minerals (Price and Bush, 1974).

Efforts have been made by researchers to produce cheese from plant sources, for example; cheese from Bambara milk (Adedokun et al., 2013; Igyor et al., 2006) and also with cassava powder (Ramkant, 2006). Little or no consideration has been put to the production of cheese using cocoa as a potential alternative source for cow milk. The success of this work will diversify the use of milk which serves as raw material for some other products to cocoa powder.

Therefore, the main objective of this work is to access the potential/possibility of cheese making with cocoa powder incorporation through the assessment of the nutrient quality of the resulting cocoa based cheese.

MATERIALS AND METHODS

Sources of materials

Fresh cow milk and Sodom apple leave were purchased from a nomadic Fulanic settlement located at Igboora, Igbole Local Government Area of Oyo State while Cocoa powder was sourced from Cocoa Research Institute of Nigeria (CRIN), Idi Ayunre, Ibadan, Oyo State, Nigeria.

Methodology

Preparation of sample

The fresh cow milk was collected from the animal aseptically and package in a sterile white plastic container. Cocoa powder was mixed with a little quantity of water and mixed (v/v) with cow milk at different proportion as shown.

Fresh cow milk (%)	*Cocoa powder solution (%)*
90	10
80	20
70	30
60	40
100	Control

Production of cheese 'warankashi'

The procedure described by Igyor et al. (2006) with little modification was used in the production of cheese 'warankashi'. Cheese samples with added cocoa powder mixture were formulated by partial substitution of cow milk with cocoa powder mixture at varied proportions while 100% cow

milk 'warankashi' was produced as reference sample (control). The blends and control samples were coagulated with 4% juice extract from Sodom apples leaves (enzyme). The extracted juice of Sodom apple was added into each formulated blends or mixed milk), respectively. Each mixture was mixed thoroughly and heated slowly at 1°C/min until a temperature of 100°C was reached. A yellowish grey liquid whey and transparent scum-curd was precipitated. The mixture was filtered to remove the scum and floating dirt. The curd was cooked further for five (5 min) minutes and the curd from each blend was finally moulded, cut into round shapes, aseptically packaged and stored refrigerated for further analytical works.

Chemical analysis

Determination of proximate composition

The moisture, ash, protein, crude fibre and fat (ether extract) contents were determined using a standard method (AOAC, 2000). Meanwhile the carbohydrate content was calculated by difference.

Determination of mineral content

The Iron content was measured colorimetrically at 480 nm using the method of Egan et al. (1981). For the calcium content, the reading of concentration was done on a spectrophotometer (AAS) while the method used for sodium content determination was flame photometric. The zinc and Phosphorus contents were also determined. All these parameters were determined according to the method of Egan et al. (1981).

Determination of vitamin A (beta-carotene) content

The vitamins A and C contents were determined using a standard method (AOAC, 1984). Using the formula.

Determination of phytochemicals

Phenol and Flavonoid was determined according to the method of Harborne (1973). The determination of tannin contents was done at 0.2 g of finely ground sample.

Statistical analysis

Analyses were done in triplicates and the data obtained from different analysis were subjected to various statistical analysis which include simple descriptive mean and standard deviation, Analysis of Variance (ANOVA) and Duncan's multiple range tests was used to separate the means using SPSS Software (17.00).

RESULTS AND DISCUSSION

The result of proximate analysis of cheese produced with cocoa powder

The proximate composition of cheese produced with added cocoa powder is as shown in Table 1. The result showed significant difference ($P < 0.05$) in all the parameters evaluated. The

significant difference observed may be due to the cocoa powder added at varied proportions to raw whole milk during cheese making. Sample containing 80 cow milk: 20 cocoa powder had the highest moisture content (75.59%) followed by sample with 70 cow milk: 30 cocoa powder (67.82%). The lowest moisture content recorded from the analysis was 57.91%. However, the moisture content recorded seems to be high, which may be due to the nature of the raw material (majorly moisture). The highest moisture content (75.59%) is different from the result obtained and earlier reported by Aworh and Akinniyi (1989) and Fashakin and Umokiwedi (1992) who reported 61.13% and 60.8%, respectively. However, Egan et al. (1981) and Frazier and Weshoff (1988) has stressed that the moisture content is a measure of the water content and accounts for the texture of the food material. Smith (1990) stated that one of the main differences between processed spread products is the level of moisture content in the product, which affects its rheological factor. However, the result is in agreement with the finding of Uaboi-Egbenni et al. (2010). Moisture is an indication of spoilage of food. This may be linked to the high deterioration rate of cheese from cow milk. The relatively high moisture content is an indication that these cheese will have low shelf life especially when not properly stored (Eka, 1987). Proteins are essential component of the diet needed for survival of animals and humans and of which basic function in nutrition is to supply adequate amounts of required amino acids (Pugalenthi et al., 2004). The protein content of the cheese sample were significantly different ($p < 0.05$) from cheese sample with added cocoa powder. The cheese sample with (60 cow milk: 40 cocoa powder) showed the highest (21.61%) while the control sample and sample (70 cow milk: 30 cocoa powder) were the least (8.99% and 8.14%), respectively. The indication from these results implied that the addition of cocoa from 40% will significantly ($p < 0.05$) increase the protein content of the cheese.

The protein contents recorded in this study were higher than those reported by earlier researchers on cheese; 5.33% reported by Frazier and Weshoff (1988), but lower than the findings of Fashakin and Umokiwedi (1992) who reported 44.5% protein in cheese produced with added melon milk. The high protein recorded with addition of cocoa powder in this study reveal the potential influences of vegetable source of protein in cheese making which is an addition to the animal source and may serves as a cheaper source when compared to 100% cow milk. It also shows that cocoa-based cheese will have a good implication in a society with high protein deficiency and will no doubt complement protein from animal and other plant foods in the diets of Nigerians.

Lipids are essential because they provide the body with maximum energy; approximately twice that for an equal amount of protein or carbohydrate and facilitate intestinal absorption/ transportation of fat-soluble vitamins A, D, E and K (Dreon et al., 1990). Fat helps to isolate and cushion vital body organ to protest from harm, it is also a source for energy (Sofowora and Odebiyi, 1978).

Cheese samples with added cocoa mixture declined in fat contents from (10.03 to 5.94), respectively. Cheese sample with 80 cow milk: 20 cocoa powder had the highest fat (10.03%) content while sample from 60 cow milk: 40 cocoa powder showed the least fat content (5.94%). However, the variation was found significant ($p < 0.05$) and the result may be associated partly to the varying proportions of cocoa mixture used in the production and partly due to the level and nature of fat in cocoa mixture used. Akande et al. (2009) recorded a range of 7.15–8.31% fat for raw and roasted bambaranut in cheese making. Significantly, fat is important as a source of energy in human body (Onyeka, 2008) but the low value of fat recorded with the addition of high amount of cocoa powder in cheese making in this research shows that the cocoa-based

cheese may be recommended to the obese and diabetic patient who want to do away with high fat food.

The Ash content is the compound that remains after a scientific sample is burned, they are commonly referred to as residue of a food material. Vegetables ash can be used in the production of food materials like cheese (Aletor and Adeogun, 1995).

Percentage ash of sample gives an idea about the inorganic content of the samples from where the mineral content could be obtained (Bello et al., 2008). Samples with high percentages of ash contents are expected to have high concentrations of various mineral elements, which are expected to speed up metabolic processes and improve growth and development (Bello et al., 2008). The ash content of cheese samples varied significantly ($p < 0.05$) and increased among the cheese samples, except sample (70:30) which the lowest ash content. The control sample has (1.33) sample, while the sample added cocoa powder had the highest, sample (80:20). Uaboi-Egbenni et al. (2010) reported 0.6% ash content for fermented cheese sample.

According to Eromosele and Eromosele (1993), fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body. Fibre diets promote the wave-like contraction that moves food through the intestine. High fibre food expands the inside walls of the colon, easing the passage of waste, thus making it an effective anti-constipation. It also lowers cholesterol level in the blood, reduce the risk of various cancers, bowel diseases and improve general health and wellbeing. Presence of high crude fibre improves glucose tolerance and is beneficial in treating maturity on set diabetics (Eromosele and Eromosele, 1993). Similar sequence as in ash was observed on the crude fibre content of cheese sample, the value increased from 0.76 in control sample to 1.24% in 60 cow milk: 40 cocoa powder.

Carbohydrate is the large biological molecules or macro molecule consisting of carbon (C), hydrogen (H) and oxygen (O_2). The primary function of carbohydrate is to provide the body with energy especially the brain and nervous system (Aletor and Adeogun, 1995).

Total carbohydrate determined by difference on cheese ranged from 2.32 to 21.85% among the sample with added cocoa mixture, cheese sample (90:10) had the highest value (21:85%) than control sample (12:63%). According to Adewusi et al. (1995), samples with low carbohydrate content might be ideal for diabetic and hypertensive patients requiring low sugar diets.

Table 1 Result of the proximate composition of cocoa-based cheese

Sample	*Moisture (%)*	*Fat (%)*	*Protein (%)*	*Ash (%)*	*Crude Fibre (%)*	*CHO (%)*
A	57.91 ± 3.61^{d}	6.98 ± 0.99^{c}	11.26 ± 0.97^{ab}	1.21 ± 0.01^{c}	0.79 ± 0.01^{c}	21.85 ± 0.96^{a}
B	75.59 ± 1.01^{a}	10.03 ± 0.97^{a}	9.56 ± 0.96^{bc}	1.38 ± 0.01^{a}	0.85 ± 0.26^{b}	2.32 ± 0.10^{e}
C	67.82 ± 1.01^{b}	7.46 ± 0.98^{b}	8.14 ± 0.99^{c}	1.01 ± 0.01^{c}	0.96 ± 0.02^{b}	14.61 ± 0.99^{c}
D	62.39 ± 0.99^{c}	5.94 ± 0.95^{d}	21.61 ± 0.99^{a}	1.24 ± 0.01^{c}	1.01 ± 0.01^{a}	16.81 ± 1.02^{b}
E	65.10 ± 1.01^{bc}	7.19 ± 0.99^{b}	8.99 ± 1.00^{c}	1.33 ± 0.01^{b}	0.76 ± 0.01^{c}	12.63 ± 0.98^{d}

Note: Values are means of triplicate determinations ± standard deviation.
The mean value with different superscripts are significantly different ($p < 0.05$).
A – Cheese from 90 Cow milk: 10 Cocoa powder solution.
B – Cheese from 80 Cow milk: 20 Cocoa powder solution.
C – Cheese from 70 Cow milk: 30 Cocoa powder solution.
D – Cheese from 60 Cow milk: 40 Cocoa powder solution.
E – Cheese from 100% Cow milk.

The result of the mineral content of cocoa based cheese

The result of the mineral content is as shown in Table 2. Mineral elements are inorganic matter that plays important roles in human nutrition and the inadequacy may result to nutritional disorder. Calcium is a major factor for sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of vitamin b_{12} (Mensah et al., 2008).

Potassium is a mineral that is crucial for life. It is necessary for heart, kidney and other organs. Potassium is involved in the control of nerves maintenance of normal blood pressure (Elson and Haas, 2011).

The calcium content of cheese evaluated ranged between 0.29 and 0.35% while potassium ranged from 0.09 to 0.16%. The control sample had the highest (0.16%) in terms of potassium content. The value of both mineral elements increased as there was increase in added cocoa mixture in cheese. Iron is said to be an important element in the diet of pregnant women, nursing mothers, infants convulsing patients and elderly to prevent anaemia and other related diseases (Latunde-Dada, 1990; Oluyemi et al., 2006).

Sodium is an important source of electrolytes within the body. Sodium, copper and zinc contents increased from 0.107 to 0.164, 2.50 to 4.00 and 23.00 to 25.5 mg/kg, respectively that is, comparing the cheese made from 100% cow milk to the one made with the addition of cocoa powder. There was no significant difference among the samples in terms of manganese and iron was found to increase in sample with the addition of 30% cocoa powder. The changes in minerals content may be as a result of using two different raw materials of different origin (plant and animal origins) at varied proportions.

Table 2 Result of the mineral content of cocoa-based cheese

Sample	*Na (mg/g)*	*Mn (mg/g)*	*Fe (mg/g)*	*Cu (mg/g)*	*Zn (mg/g)*	*K (mg/g)*	*Ca (mg/g)*
A	0.056 ± 0.01^{e}	5.50 ± 1.10	23.00 ± 1.00^{a}	0.50 ± 0.10^{c}	19.00 ± 1.00^{c}	0.10 ± 0.01^{b}	0.32 ± 0.01
B	0.109 ± 0.01^{c}	4.50 ± 1.10	17.50 ± 1.00^{c}	3.00 ± 1.10^{ab}	20.00 ± 1.10^{c}	0.10 ± 0.01^{ab}	0.29 ± 0.01
C	0.117 ± 0.01^{b}	4.50 ± 1.10	10.00 ± 1.10^{d}	4.00 ± 1.00^{a}	25.50 ± 1.10^{a}	$0.12 \pm 0.^{01ab}$	0.35 ± 0.01
D	0.164 ± 0.01^{a}	5.00 ± 1.10	21.00 ± 1.00^{b}	3.00 ± 1.00^{ab}	25.00 ± 1.00^{b}	0.09 ± 0.01^{b}	0.33 ± 0.01
E	0.107 ± 0.01^{d}	4.00 ± 1.10	21.00 ± 1.00^{b}	2.50 ± 1.10^{bc}	23.00 ± 1.00^{ab}	0.16 ± 0.01^{a}	0.32 ± 0.01

Note: Values are means of triplicate determinations ± standard deviation.
The mean value with different superscripts are significantly different ($p < 0.05$).
A – Cheese from 90 Cow milk: 10 Cocoa powder solution.
B – Cheese from 80 Cow milk: 20 Cocoa powder solution.
C – Cheese from 70 Cow milk: 30 Cocoa powder solution.
D – Cheese from 60 Cow milk: 40 Cocoa powder solution.
E – Cheese from 100% Cow milk.

Result of the vitamin content of cocoa-based cheese

The result of the vitamin content of cocoa-based cheese is as shown in Table 3. Vitamin C increases from 0.251 to 0.317 µg/g with the control having the lowest and sample prepared from 60% cow milk: 40% cocoa powder having the highest. The result of vitamin A increased from (166 to 204 mg/100g) with the addition of cocoa powder while sample (70:30) has the lowest value (166.00 mg/g). Therefore it can be deduced from this findings that cocoa powder could be a good source of Vitamins C and A that the body can derive from cheese.

Table 3 Result of vitamin content of cocoa-based cheese

Sample	*Vit A (mg/100g)*	*Vit C (mg/100g)*
A	198.00 ± 1.00^{b}	0.266 ± 0.001^{d}
B	174.00 ± 1.00^{c}	0.305 ± 0.001^{b}
C	166.00 ± 1.00^{e}	0.274 ± 0.001^{c}
D	204.00 ± 1.00^{a}	0.317 ± 0.001^{a}
E	169.00 ± 1.00^{d}	0.251 ± 0.001^{e}

Note: Values are means of triplicate determinations ± standard deviation.
The mean value with different superscripts are significantly different ($p < 0.05$).
A – Cheese from 90 Cow milk: 10 Cocoa powder solution.
B – Cheese from 80 Cow milk: 20 Cocoa powder solution.
C – Cheese from 70 Cow milk: 30 Cocoa powder solution.
D – Cheese from 60 Cow milk: 40 Cocoa powder solution.
E – Cheese from 100% Cow milk.

The result of phytochemical analysis

Phytochemicals are non-nutritive chemicals that occur naturally in plants. These phyto-constituents were reported as antibiotic principles of plants and they offer benefits (prevent cell damage and fight infections) in plants and animals when ingested by them in food (Ajayi et al., 2011). Certain phytochemicals have anti-nutritional properties (side effects), when ingested in excess. Cyanide and tannins bind essential minerals such as calcium, iron, magnesium and zinc in the digestive tract to form insoluble salts, thereby decreasing or reducing bioavailability or absorption of nutrients (Armstrong et al., 1974).

The observation from the result of phytochemical analysis on cocoa-based cheese showed a significant ($p < 0.05$) increase in phenol of cheese sample from (1.58%) in 90:10 sample to (2.64%) 70:30 sample, while the control shows to contain (2.08%) phenol. Flavonoids have been reported to possess substantial anti-carcinogenic and anti-mutagenic activities due to their anti-oxidant, anti-inflammatory properties and also active in reducing high blood pressure (Ayinde et al., 2007; Li-Weber, 2009).

Table 4 Result of phytochemical content of cocoa-based cheese

Sample	*Phenol (%)*	*Tannin (%)*	*Flavonoid (%)*
A	1.58 ± 0.01^{e}	2.07 ± 0.01^{c}	8.14 ± 0.01^{c}
B	2.58 ± 0.01^{b}	1.98 ± 0.01^{d}	9.93 ± 0.01^{b}
C	2.64 ± 0.01^{a}	2.11 ± 0.01^{b}	8.03 ± 0.01^{d}
D	2.01 ± 0.01^{d}	1.86 ± 0.01^{e}	11.87 ± 0.01^{a}
E	2.08 ± 0.01^{c}	2.14 ± 0.01^{a}	7.08 ± 0.01^{e}

Note: Values are means of triplicate determinations ± standard deviation.
The mean value with different superscripts are significantly different ($p < 0.05$).
A – Cheese from 90 Cow milk: 10 Cocoa powder solution.
B – Cheese from 80 Cow milk: 20 Cocoa powder solution.
C – Cheese from 70 Cow milk: 30 Cocoa powder solution.
D – Cheese from 60 Cow milk: 40 Cocoa powder solution.
E – Cheese from 100% Cow milk.

The control sample (100% cow milk) contains the lowest value of flavonoids while sample (60 cow milk: 40 cocoa powder) had the highest value (Table 4). The Tannin content declined from (2.14%)

in control sample to (1.86%) sample 60 cow milk: 40 cocoa powder, which is the least value. This report on reduced tannin content with addition of cocoa powder to cow milk in cheese making could be said to be desirable since according to researchers high amount of tannin consumption in food is not recommended (Fasuyi, 2006). A correlation has been made between oesophageal or nasal cancer in human regular consumption of certain herbs with high tannin concentration (Mensah et al., 2008).

CONCLUSION AND RECOMMENDATION

The investigation on nutrient composition of cocoa-based cheese in this study has showed the potential influence of adding cocoa powder mixes as readily available and highly nutritious vegetable source in addition to cow milk for soft cheese 'warankashi' making.

It showed the possibility of using cocoa powder in cheese production to enhance the nutrient of soft un-ripened cheese because the addition of cocoa powder to cow-milk in its production resulted into an increase in protein, phytochemicals and minerals evaluated except fat and tannin contents which are desirable for healthy leaving.

The research has revealed other possible use for cocoa powder in food processing and technology.

It is however recommended that other qualities such as consumer's acceptability, physical and microbiological stability of the cocoa-based cheese should be evaluated.

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