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Physicochemical Composition, Antioxidant Profile and Sensorial Acceptability of Melon Seed-Coconut Milk Alternative Cheese

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Abstract
This work evaluated the physicochemical composition, antioxidant profile and sensory scores of melon seed-coconut (MS-CC) cheese formulated at the ratio of MS-CC milk: 90:10, 70: 30, 50:50, 70:30 with 100% cow milk (CM) as the control. The melon seed (MS) and coconut (CC) were purchased at Ubani main market, Umuahia, Abia State in good physiological condition and processed according to standard methods. The proximate results showed that the cheese produced from MS-CC milk had higher concentrations of moisture, protein, fat and fibre, especially in MS90:10CC cheese than the control cheese, which was higher in ash, carbohydrate and energy contents. Other physicochemical results showed that Na, Mg, P, K, Fe, Zn and vitamins E, B_1 and B_3, pH and TS were higher in control cheese than the MS-CC cheese. However, Ca, TTA, vitamins A and B_2 were higher in MS-CC cheese, especially the MS30:70CC formulation. The antinutrient properties revealed that alkaloids, saponin, tannin, phytate and cyanide were far higher in the MS-CC cheese, especially in MS90:10CC formulation which was about 1-9folds when compared to control cheese. The correlation results shows that flavonoid correlated positively with DPPH and FRAP assays at $R^2 = 0.671$, while phenol and ABTS, FRAP correlated negative at $R^2 = -0.873$. The sensory scores revealed that the control, MS50:50CC and MS30:70CC cheese was above 70% in general acceptability. The study highlighted that acceptable substitute cheese can be made from MS30:70CC formulation and can be used to promote the diversification of MS-CC milk beyond the traditional usage.

Keywords: Cow milk cheese, Melon seed-Coconut cheese, physicochemical properties, antioxidant activity, sensory evaluation

Introduction

Cheese is a dairy product derived from milk of cows, buffalo, goats and sheep (Balogun *et al*., 2019; Grasso *et al*., 2021). Today, cheese is an important food product spanning through many cultures and is produced in various diversity of flavours, textures and consumption patterns (McSweeney *et al*., 2017). There are different types of cheese currently available. Cheddar cheese, which originated in England, is one of the most important varieties worldwide and it is considered a hard cheese that is made from pasteurized cows' milk, coagulated with calf rennet or a rennet substitute (McSweeney *et al*., 2004). Other types of cheese include semi-hard cheeses, and soft cheeses, depending on their moisture content, and their ripening agents like bacteria and moulds.

For many reasons, interest in plant-based foods designed to provide an alternative to cow's cheese products is of increasing interest. There is the concern on the impact of cheese of animal origin on human health, followed by the scarceness and un-affordability of cow's milk and products have brought a major limitation on the much usage of cow's milk in cheese production. Furthermore, there is the need to develop more sustainable and nutritious food products to meet the rapidly increasing population that require adequate nutrition (Grasso *et al*., 2021). Moreover, dietary shifts from consumption of meat and dairy to plant-based diets with high phytonutrients offer potential to benefit consumer's health (Ekanem and Ojimelukwe, 2017). These factors have made the search for less expensive plant milk-based products that could be used as substitutes for animal milk products or to augment their use for effectiveness in boosting health and fighting protein-energy malnutrition. This need is very urgent in under-developing economies such as Nigeria with a population of over 200 million people as diary production has plunged downwards in recent years. Desertification, a major climate change problem has, for instance triggered the nomads and herdsmen to relocate from Northern to Middle belt and Southern Nigeria for greener pasture. It has had colossal consequences as farmers and herders continuously clash in these regions, and thus diminishing not only animal products, but also crop production.

A number of plant-based products have been consumed in different cultures as traditional foods for centuries (Balogun *et al*., 2019). Soybean has been used to produce various plant-based cheese-like products such as *tofu* and *tempeh* (Balogun *et al*., 2019). Moreover, other plant-based foods were employed for the production of products as alternatives to cheese. They include rice, coconut milk, sunflower seed, pumpkin seed, melon seed, cashew, tiger and almond nuts. These are generally processed by soaking with water, and ground and fermented to obtain the final product (Diarra *et al*., 2005; Belewu and Belewu, 2007), as stock for alternative cheese production. In this study, melon seed and coconut milk were utilized for alternative cheese production due to their availability and lower cost materials than cow milk.

Melon (*egusi*) seed (*Citrullus colocynthis L.*) is a member of *cucurbitaceous* family that has been shown to contain 53% oil, 33% proteins, 44% oil, 10% carbohydrate, 4% ash and 3% fiber (Abiodun and Adeleke, 2010; Ogbonna and Obi *et al*, 2010). A study revealed that melon seed is rich in essential amino acids like arginine, glutamine, aspartic acid, macro-micro minerals, and essential fatty acids (Olamide *et al*, 2011). Melon seed is also a rich source of flavonoids and phenolic compounds and possess antioxidant activity for scavenging free radical actions and inhibit hydrolytic and inflammatory activities (Ayo-Lawal *et al,* 2020).

The coconut (*Cocos nucifera L.*) is a member of Arecaceae family (Akoma *et al*., 2000). The coconut palm is found throughout the tropics, especially in Southeast Asia, Indian Subcontinent, Africa, Central America and Melanesia. Coconut milk is usually used as a food ingredient in various traditional cooking recipes (Seow and Gwee, 1997). Coconut milk is obtained by manual or mechanical extraction of maturely grated coconut meat with or without added water (Santana *et al*., 2017). Coconut milk has a typical composition of about 50% moisture, 34% oil, 3.5% protein, 3% fiber, 2.2% ash and 7.3% carbohydrates (Santana *et al*., 2017). The fat content of coconut milk is majorly lauric acid, which exhibit antibacterial, antifungal and antiviral properties. Coconut milk also contains several antioxidant compounds that provide protection against harmful free radical effect in the body cells and as a result, boost immune system. Containing about 22% of the recommended daily allowance of iron, coconut milk can help arrest iron deficiency anemia. Therefore, the aims of this study were to evaluate the physicochemical composition, antioxidant profile and sensory acceptability of melon seed-coconut milk-based alternative cheese.

Materials and Methods

Source of raw material

The melon seed (MS) and coconut (CC) including other ingredients used in this study were purchased at Ubani main market, Umuahia, Abia State. The reagents used in the laboratory analyses were of analytical grades.

Preparation of coconut milk

The method of Ekanem and Ojimelukwe (2017) was adopted for the production of CC milk. Fresh matured coconut was unshelled and the meat washed and grated using a traditional coconut grater, the shredded pulp (100g) was mixed with warm distilled water (500ml) at 60°C in a blender (Sanyo SM-B12M), and filtered through a double layer cheese cloth. It was manually squeezed with a twisting motion to extract most of the milk. It was filled in a plastic container and cooled in a refrigerator at 4°C for further use.

Preparation of melon seed milk

The MS milk was produced according to the method described by Omole and Ighodaro (2012). Exactly 100g of shelled, dried and sorted melon seed was blended in an electric blender (Tefal Smart, France). Then 500ml of clean water was added to it and strained using a muslin cloth to obtain the melon milk. The milk was packaged in a plastic container and cooled in a refrigerator at 4°C for future use.

Preparation of cheese

The method of Ocansey (2010) was adopted in the cheese production. One liter of CC milk and MS milk was heated gradually in a container. Exactly 1g of common salt (coagulant) was added to the milk. The temperature was quickly raised to 90°C till coagulation was completed. Cheese cloth was used to drain the whey and the curd was allowed the curd get firm and form. The product was then kept in the refrigerator for storage prior to analyses. The 100% cow milk cheese sample was used as the control.

Determination of proximate composition of cow milk and melon-seed-coconut-milk cheese

The proximate composition values (moisture, crude protein, ash, crude fat, crude fibre and carbohydrate) were determined by the method described according Onwuka (2018). Energy value (kcal per 100 g) was estimated using the Atwater conversion factor. Energy (kcal per 100 g) = (9 × Lipids% + 4 × Proteins% + 4 × Carbohydrates%).

Determination of mineral composition of cow milk and melon-seed-coconut-milk cheese

The method of AOAC (2005) was used. A solution of ash sample was dissolved in a drop of trioxonitrate (V) acid and made up to 50ml with deionized water. The Ca, Mg, Cu, and Zn were analyzed using the atomic absorption spectrophotometer, while Na and K were analyzed in a flame photometer, and P was analyzed in a UV-Visible Spectrophotometer after making ammonium vanadate molybdate complex at 436nm.

Determination of vitamins content of cow milk and melon-seed-coconut-milk cheese

The vitamin A (carotenoid) content of the sample was determined using the method described by Delia *et al*. (2004). The cheese samples were extracted with cold acetone and then partitioned with petroleum ether. The aqueous phase after partitioning was discarded and the petroleum ether phase was washed thrice to remove residual acetone. It was then passed through a funnel containing anhydrous sodium sulfate to remove residual water and the absorbance read at 450nm using a spectrophotometer. Vitamin A was calculated using 12µg β-carotene as 1 µg retinol activity equivalents.

$$\beta\text{-carotene content (mg/g)} = \frac{\text{A X Volume (ml) X } 10^4 \text{ Xdf}}{\text{A}^{1\%} \text{ tcm X weight of samle}}$$

Where A = Absorbance, Volume = Total volume of extract, $A^{1\%}$ cm = Absorbance Coefficient of β-carotene in petroleum ether (2592). By multiplying the result with 100, the carotenoid content in µg/100g was obtained. Thiamine (Vitamin B_1), riboflavin (Vitamin B_2), niacin (Vitamin B_3) was determined by spectrophotometric method described by Okwu (2004), while vitamin E was determined by AOAC (2005).

Physicochemical composition of cow milk and melon-seed-coconut-milk cheese

The pH, total solid and total titratable acidity of cheese sample was determined by using a method described by Onwuka (2018).

Determination of antinutrient content of cow milk and melon-seed-coconut-milk cheese

The tannin content was determined using Folin-Denis Spectrophotometric method as described by Onwuka (2018). The phytate content was determined using the method described by Onwuka (2018). The alkaloid content of the test sample was determined by the gravimetric method as described by Onwuka (2018). The method according to Onwuka (2018) was used to determine cyanogenic glycoside content, and total saponin content was determined by using the vanillin-sulphuric acid spectrophotometric method of Hiai *et al*. (1976), and absorbance of mixture was measured at 560nm.

Determination of antioxidant activity of cow milk and melon-seed-coconut-milk cheese

The DPPH (2,2-Diphenyl-1-picrylhydrazyl) was determined using the method described by Katalinic *et al*. (2006). The FRAP assay was determined following the method described by Moharram and Youssef (2014), while ABTS was determined by the method described by Stratil *et al*. (2006).

Sensory evaluation of cow milk and melon-seed-coconut-milk cheese

The sensory evaluation of coded samples was evaluated using 30 semi-trained students of the Department of Food Science and Technology, Michael Okpara University of Agriculture who were familiar with cheese products. Water was used to rinse the mouth in between the samples. Panelists evaluated the samples for colour, aroma, taste, texture, mouthfeel and general acceptability using a 9-point hedonic scale (9=like extremely and 1= dislike extremely) according to Iwe, (2002).

Statistical analysis of cow milk and melon-seed-coconut-milk cheese

Experimental data were analyzed by one-way analyses of variance (ANOVA) using SPSS version 22 and means were separated by using Duncan Multiple Range Test (DMRT) at a significant level $p<0.05$. Results were expressed as the means ± standard deviation of two separate determinations.

Results and Discussion

Proximate composition of cow milk and melon seed-coconut cheese

The proximate values of MS-CC and control cheese are presented in Table 2. The moisture content of MS-CC cheese ranged from 56.31 to 59.93%. These values were significantly ($p<0.05$) higher than the control cheese (CM) (51.45%). It increased with increment in MS milk inclusion. However, the moisture results showed the characteristic of soft cheese, but were within the range of coconut/tiger-nut cheese reported by Ocansey (2010). This high moisture content can permit the rapid growth and proliferation of microorganisms, which can adversely affect the shelf stability of the cheese products (Orhevba and Taiwo, 2016). The protein content varied from 9.84 to 20.15%. The result revealed that MS milk increment resulted to higher protein availability, about 50% more than the control cheese (100% CM). Soy-tiger-nut and soy-coconut cheese were reported to contain similar range of protein content (Balogun *et al*., 2019; Ayodeji *et al*., 2020). Melon seed flour was previously reported to contains 23.4% protein (Abdulhamid *et al.,* 2013)), and it contributed to the high protein content of MS-CC cheese. The fat content of our cheese products varied significantly from 3.79 to 7.47%, and it increased with increase in MS milk inclusion. MS90:10CC cheese had the highest fat content (7.4%), while the MS30:70CC cheese formulation was the lowest (5.32%), but was higher than the 100% cow milk cheese (3.79%). Tijani (2014) also showed similar range of fat values of 3.52 to 8.27% in soy-tiger nut cheese. Being a plant cheese with high concentrations of protein and fat, this product can act as a functional food and a boost to the amelioration of protein-energy malnutrition.

The crude fibre content of MS-CC substitute cheese samples ranged from 0.11 to 0.73%, and it showed that increase in fibre content was derivable from coconut milk. This was evident in MS30:70CC cheese, which was about 30-70% higher than the 100% CM cheese. The fiber content was slightly lower than the report of Balogun *et al*. (2019) on soy-tiger nut cheese. The ash content of the MS-CC cheese ranged from 1.41 to 1.71%. They were lower than the control sample (100% CM cheese) (2.10%). The ash content of MS-CC cheese increased with increase in coconut milk addition. The result in this study agrees with the report of Balogun *et al*. (2016, 2019) on cow milk-coconut milk and soy milk and tiger-nut milk cheese ash contents. In like manner, the carbohydrate content of the 100% cow milk cheese was higher than the MS-CC cheese, with values ranging from 10.76 to 32.73%. These were in contrast to the report of Ekanem and Ojimelukwe, (2017) on coconut and cow milk cheese. The energy value revealed that CM cheese (204.33 Kcal) was higher than the values of MS-CC cheese (190.77 to 199.25 Kcal). The lower energy value of MS-CC cheese can be beneficial to those that are shedding calories, and those on special dietary needs like lactose free, low saturated fat and cholesterol.

Mineral composition of cow milk and melon seed-coconut cheese

The result of the minerals composition of the cheese samples are presented in Table 3. The calcium content of MS-CC cheese increased from 825.31 to 962.13mg/100g as MS milk addition increased, with MS90:10CC cheese having the highest calcium content. The calcium values in this study were lower than those reported by Aljewicz and Cichosz (2015) for cheese and cheese-like products. Notably, the calcium content of MS-CC cheese was higher than that of CM cheese (702.26mg/100g). On the contrary, sodium (674.17mg/100g), magnesium (104.04mg/100g), phosphorus (50.12mg/100g), potassium (160.22mg/100g), iron (5.87mg/100g) and zinc (5.12mg/100) were about 25 to 50% higher in CM cheese compared to MS-CC cheese. However, the results showed greater increases of these mineral elements as CC milk inclusion increased in the MS-CC cheese. Dietary minerals requirement is important in boasting minerals nutrition against deficiencies for better physiological competence. Calcium and phosphorus, potassium and sodium, zinc and iron perform diverse biological functions in the human body, for bone and skeletal development, especially for growing children, maintain osmotic balance and regulates the body pH, and for potassium alone, protects the body from hypertension, while zinc and iron are involved in heamopoisis, to prevent morbidity and mortality in children (Weaver and Heaney, 2006; Bello *et al*., 2017).

Vitamin composition of cow milk and melon seed-coconut substitute cheese

The result of the vitamins composition of the various cheese samples are presented in Table 4. Generally, vitamin A content of the cheese varied from CM (371.03) to MS-CC (440.27mg/100g). Interestingly, MS-CC cheese revealed higher concentrations of vitamin A as a result of coconut milk inclusion. By implication, MS30:CC70 cheese had the highest vitamin A value (440.27mg/100g), while MS90:CC10 cheese had the lowest vitamin A value (406.65mg/100g), but was higher than CM cheese (371.03mg/100g). Ekanem and Ojimelukwe also reported increase in vitamin A concentration as a result of coconut inclusion in CC-CM cheese. For vitamin B_1, 100% CM cheese (0.76mg/100g) was higher than 0.38 to 0.43 mg/100g reported for MS-CC cheese samples. Coconut milk inclusion increased B_1 content in MS-CC cheese marginally as the proportion increased. Similarly, vitamin B_2 increased with increase in coconut milk inclusion from 2.18 to 2.68mg/100g in MS-CC cheese, while CM cheese had the lowest value (1.13mg/100g). Although B_3 was highest in CM cheese (3.81mg/100g), it was also observed that vitamin B_3 concentrations increased marginally from 1.38 to 1.96mg/100g with increment in coconut milk inclusion in MS-CC cheese. The vitamin E result revealed that CM cheese had higher vitamin E value (0.62mg/100g) when compared to MS-CC cheese (0.38 to 0.47mg/100g). CM cheese was found to possess higher concentrations of vitamins B_1, B_3 and vitamin E, while coconut milk significantly contributed to high concentrations of all the vitamins in MS-CC cheese. Vitamins nutrition is vital to the maintenance and regulation of some important functions of the body. Vitamin A is a micro nutrient that positively impact vision, immune competence and reproduction. Vitamins A and E are strong antioxidant that are effective in scavenging free radicals and prevent non-communicable disorders in the human body.

Chemical composition of cow milk and melon seed-coconut cheese

The results of the chemical composition of the cheese samples varied significantly and are presented in Table 5. pH is a measure of the H^+ concentration of the cheese samples. It revealed that CM cheese (pH 6.97) was higher in pH value than MS-CC cheese (pH 6.13 to 6.92) samples. However, increment in coconut milk increased the pH values of MS-CC cheese as can be observed in MS30:CC70 milk (pH 6.92). Lower pH (higher acidity) was attributable to higher inclusion of MS milk. In comparison, the pH values obtained in this study were higher than those reported by Balogun *et al*. (2019). The pH values for both CM and MS-CC cheese can tolerate the growth and proliferation of bacteria in the cheese samples, leading to spoilage. The TTA value of CM cheese (0.07%) was lower when compared to MS-CC cheese (0.08-0.19%) samples. The observation was that as the MS milk inclusion increased, the TTA values of MS-CC cheese increased proportionately. The TTA was lower than 0.25 to 0.45% (Ekanem and Ojimelukwe, 2017) for CM-CC cheese and 0.20 to 0.32% (Balogun *et al*., 2019) for tiger-nut soybean cheese. For total solid, the value of CM cheese was higher than those of MS-CC cheese. The results also showed that CC milk impacted on the total solid contents of MS-CC cheese samples, revealing that MS50:CC50 milk inclusion maintained the highest total solid value (43.70%) among the MS-CC cheese samples.

Antinutrient content of cow milk and melon seed-coconut milk cheese

The results of the antinutritional factors of the various cheese samples are presented in Table 6. The formulations involving MS milk was observed to generally have higher ($p<0.05$) values of anti-nutritional properties than the CM (animal) cheese product. The alkaloid content of CM cheese was lowest (0.41%). However, those of MS-CC cheese ranged from 0.68 to 1.87% with increase in melon seed milk inclusion. As a result, MS90:10CC milk cheese had the highest alkaloid value (1.87 %), while MS30:CC70 milk cheese was the lowest alkaloid value (0.68 %). Similarly, the saponin content of the cheese samples was least in CM cheese (0.19%). But higher range of 1.01 to 1.42% was observed in the MS-CC cheese samples and it increased with increase in MS milk inclusion, therefore making MS90:10CC cheese to have the lowest saponin content. Saponins have been reported to lower plasma cholesterol concentration (Umaru *et al*., 2007). As the trend continues, the tannin content of the cheese samples was found to increase from 1.43 to 2.06% with increase in MS milk inclusion. The tannin content (1.05%) of CM cheese was found to be lower than the MS-CC cheese samples. Tannin is nontoxic but can generate physiological responses in animals that consume them (Lawal *et al*., 2014). This is because tannins are polyphenolic compounds that can exert antioxidant properties *in vivo*. Also, the phytate content of MS-CC cheese samples increased from 0.87 to 1.48% with increase in MS milk addition with MS90:CC10 cheese as the highest phytate value (1.48%). The result also showed that CM cheese possessed high phytate content (1.13%) more than formulations MS50:50CC (1.08%) and MS30:70CC cheese (0.87%), respectively. These results depict that CM is equally high in phytate content. High concentration of phytate in foods can cause adverse effect on protein digestibility. Phytic acid binds metals like calcium, phosphorus, zinc, iron and other minerals, thereby reducing their bioavailability in the body (Verla *et al*., 2014). The cyanide contents of MS-CC cheese samples varied from 0.52 to 0.95 mg/kg, and were found to be higher than 0.07 mg/kg reported for CM cheese. The cyanide contents increased with increase in MS milk inclusion but were far below the maximum safe level of 10 to 20 mg/kg recommended by different regulatory agencies (Sanni *et al*., 2005).

Antioxidant activity of cow milk and melon seed-coconut milk cheese

The antioxidant activity of the cheese is presented in Fig.1. From the result, flavonoid content was significantly ($p<0.05$) higher in MS30:70CC cheese and ranged from 10.27 to 17.47mgQ/g. It shows that flavonoid content increased progressively with increase in coconut milk (30 to 70%), in the order 10.27 < 11.52 < 13.03 < 17.47mgQ/g, revealing that coconut milk was a major contributor of flavonoids in the cheese. The reverse was the case in CM cheese as the flavonoids content was the least value (7.36mgQ/g) when compared to MS-CC cheese. On the other hand, phenol content increased with the increment of MS milk from 4.15 to 13.15mgGAE/g. The phenol content was lowest in CM cheese (3.38mgGAE/g). While flavonoids content was high in coconut milk, phenol was high in melon seed milk. Furthermore, the %DPPH, ABTS and FRAP varied significantly from 0 to 16.17%, 4.88 to 19.32μMTE/100g and 4.15 to 8.03μMTE/100g, respectively. The results of the antioxidant assays (%DPPH, ABTS and FRAP) increased in a dose response relationship linearly as the coconut milk increased from 70 > 50 > 30 > 10% in MS-CC cheese. It was observed that %DPPH, ABTS and FRAP values were also high in CM cheese, namely, 10.14%, 15.21μMTE/100g, and 5.83μMTE/100g, respectively. It means that CM contains some antioxidant constituents in high concentrations to contribute to antioxidant activity power.

Correlation coefficient of antioxidant activity of cow milk and melon seed-coconut cheese

The results of the correlation coefficient are presented in Table 7. It showed that flavonoid correlated positively with DPPH and FRAP at $R^2 = 0.844$, and 0.671. This suggests that flavonoids contributed to strong DPPH and FRAP scavenging activity of the cheese samples. However, phenol correlated negatively with ABTS and FRAP at $R^2 = -0.873$ and -0.822, respectively. It proves that the cheese contains antioxidant constituents that can help to stop free radical actions in the body when consumed.

Sensory acceptability of cow milk and melon seed-coconut milk cheese

The results of the sensory evaluation of the cheese samples are presented in Table 8. The results revealed that CM cheese was more preferred (74.5%), and the acceptability of the MS-CC cheese stood at 6.00 to 7.10%. For the MS-CC cheese, CC milk addition progressively increased the appearance (5.10 to 6.85), taste (5.20 to 6.90), flavor (6.10 to 6.42) and texture (5.40 to 7.45). It suggests that MS milk addition would have lower sensory acceptability in cheese production. The overall result showed that when CC milk (naturally clean taste) inclusion increased from 30 to 70%, the sensory acceptability of the cheese products rose above 60%. Being a plant substitute cheese with greater concentration of antioxidant compounds, the utilization for food will not pose health problems in comparison with cheese product of animal origin like cow milk.

Conclusion

Production of cheese from MS-CC milk blends shows that MS-CC milk blends can be used to produce cheese of high nutrient density such as protein, fiber, fat, calcium, vitamin A and antioxidant activities, and less acidity. CC milk inclusion at 30 to 70% did not only enhance the micronutrients, but also the overall acceptability of the MS-CC cheese. The higher fat contents of MS-CC cheese are nothing to fear about since they are of plant sources. Cheese from MS30:70CC milk appears promising as value added product and can be promoted as a means furthering the utilization of MS-CC milk beyond the traditional usage.

Declaration of conflict of interest

The authors declare no conflicting interest.

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Table 1: Formulation recipe for cow milk and melon seed milk-coconut milk cheese (%)

Sample	Melon seed milk	Coconut milk	Cow milk
A	-	-	100
B	90	10	-
C	70	30	-
D	50	50	-
E	30	70	-

Table 2: Proximate composition of cow milk and melon seed-coconut cheese (%)

Sample	Moisture	Crude protein	Crude fiber	Fat	Ash	CHO	Energy
A	51.45^{e}±0.06	9.84^{e}±0.01	0.11^{e}±0.11	3.79^{e}±0.01	2.10^{a}±0.02	32.73^{a}±0.02	204.33^{a}±0.08
B	59.93^{a}±0.04	20.15^{a}±0.01	0.31^{d}±0.31	7.47^{a}±0.02	1.41^{e}±0.01	10.76^{e}±0.00	190.77^{d}±0.22
C	56.76^{b}±0.04	17.57^{b}±0.01	0.42^{c}±0.42	6.81^{b}±0.01	1.53^{d}±0.01	16.92^{d}±0.01	199.25^{b}±0.13
D	56.31^{d}±0.04	14.87^{c}±0.01	0.51^{b}±0.51	6.03^{c}±0.02	1.61^{c}±0.01	20.70^{c}±0.01	196.47^{c}±0.19
E	56.44^{c}±0.05	10.05^{d}±0.02	0.73^{a}±0.73	5.32^{d}±0.01	1.71^{b}±0.01	25.77^{b}±0.00	191.14^{d}±0.21

Values are the means of duplicate determinations ± standard deviations. A=100% CM cheese, B=MS90:10CC cheese, C=MS70:30CC cheese, D=MS50:50CC cheese, E=MS30:70CC cheese

Table 3: Mineral composition of cow milk and melon seed-coconut milk cheese

Sample	Calcium (mg/100g)	Sodium (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)
A	702.26^{e}±0.03	674.17^{a}±0.02	104.05^{a}±0.03	50.12^{a}±0.01	160.22^{a}±0.02	5.87^{a}±0.02	5.12^{a}±0.02
B	962.13^{a}±0.02	311.91^{e}±0.01	65.16^{e}±0.01	35.25^{e}±0.03	129.13^{e}±0.03	2.82^{e}±0.01	2.88^{e}±0.01
C	950.33^{b}±0.02	345.18^{d}±0.01	73.26^{d}±0.03	39.32^{d}±0.03	131.85^{d}±0.04	2.92^{d}±0.02	3.05^{d}±0.01
D	886.16^{c}±0.04	364.17^{c}±1.39	75.22^{c}±0.03	40.46^{c}±0.03	139.75^{c}±0.02	2.93^{c}±0.03	3.17^{c}±0.01
E	825.31^{d}±0.01	481.28^{b}±0.01	86.23^{b}±0.03	43.28^{b}±0.01	148.32^{b}±0.02	3.03^{b}±0.02	3.86^{b}±0.01

Values are the means of duplicate determinations ± standard deviations. A=100% CM cheese, B= MS90:CC10 cheese, C=MS70:30CC cheese, D=MS50CC:50 cheese, E=MS30:CC70 cheese

Table 4: Vitamin composition of cow milk and melon seed-coconut milk cheese

Sample	Vitamin A (mg/100g)	Vitamin B1 (mg/100g)	Vitamin B2 (mg/100g)	Vitamin B3 (mg/100g)	Vitamin E (mg/100g)
A	371.03^{e}±0.02	0.76^{a}±0.00	1.13^{e}±0.01	3.81^{a}±0.01	0.62a±0.01
B	406.65^{d}±0.04	0.38^{d}±0.01	2.18^{d}±0.02	1.38^{e}±0.01	0.42^{c}±0.01
C	410.02^{c}±0.01	0.39^{d}±0.01	2.32^{c}±0.01	1.73^{d}±0.01	0.38^{d}±0.01
D	427.95^{b}±0.01	0.41^{c}±0.01	2.42^{b}±0.02	1.81^{c}±0.01	0.39^{d}±0.01
E	440.27^{a}±0.01	0.43^{b}±0.01	2.68^{a}±0.01	1.96^{b}±0.01	0.47^{b}±0.01

Values are the means of duplicate determinations ± standard deviations. A=100% cheese, B=MS90:10CC cheese, C=MS70:30CC cheese, D=MS50:50CC cheese, E=MS30:70CC cheese

Table 5: Chemical composition of cow milk and melon seed-coconut milk cheese

Sample	pH	TTA (%)	TS (%)
A	6.97^{a}±0.02	0.07^{e}±0.01	48.55^{a}±0.06
B	6.13^{e}±0.01	0.19^{a}±0.00	40.08^{e}±0.04
C	6.31^{d}±0.01	0.14^{b}±0.01	43.25^{d}±0.04
D	6.52^{c}±0.00	0.12^{c}±0.01	43.70^{b}±0.04
E	6.92^{b}±0.01	0.08^{d}±0.00	43.57^{c}±0.05

Values are the means of duplicate determinations ± standard deviations. A=100% CM cheese, B=MS90:10CC % cheese, C=MS70:30CC cheese, D=MS50:50 cheese, E=MS30:70CC cheese

Table 6: Antinutrient content of cow milk and melon seed-coconut milk cheese

Sample	Alkaloid (%)	Saponin (%)	Tannin (%)	Phytate (%)	Cyanide (mg/kg)
A	0.41^{e}±0.01	0.19^{e}±0.01	1.05^{e}±0.02	1.13^{c}±0.01	0.07^{e}±0.01
B	1.87^{a}±0.01	1.42^{a}±0.02	2.06^{a}±0.02	1.48^{a}±0.01	0.95^{a}±0.01
C	1.82^{b}±0.01	1.32^{b}±0.01	2.05^{b}±0.02	1.25^{b}±0.02	0.87^{b}±0.01
D	1.53^{c}±0.01	1.24^{c}±0.00	1.85^{c}±0.00	1.08^{d}±0.00	0.81^{c}±0.00
E	0.68^{d}±0.01	1.01^{d}±0.01	1.43^{d}±0.01	0.87^{e}±0.01	0.52^{d}±0.01

Values are the means of duplicate determinations ± standard deviations. A=100% CM cheese, B=MS90:10CC cheese, C=MS70:30CC cheese, D=MS50:50CC cheese, E=MS30:70CC cheese

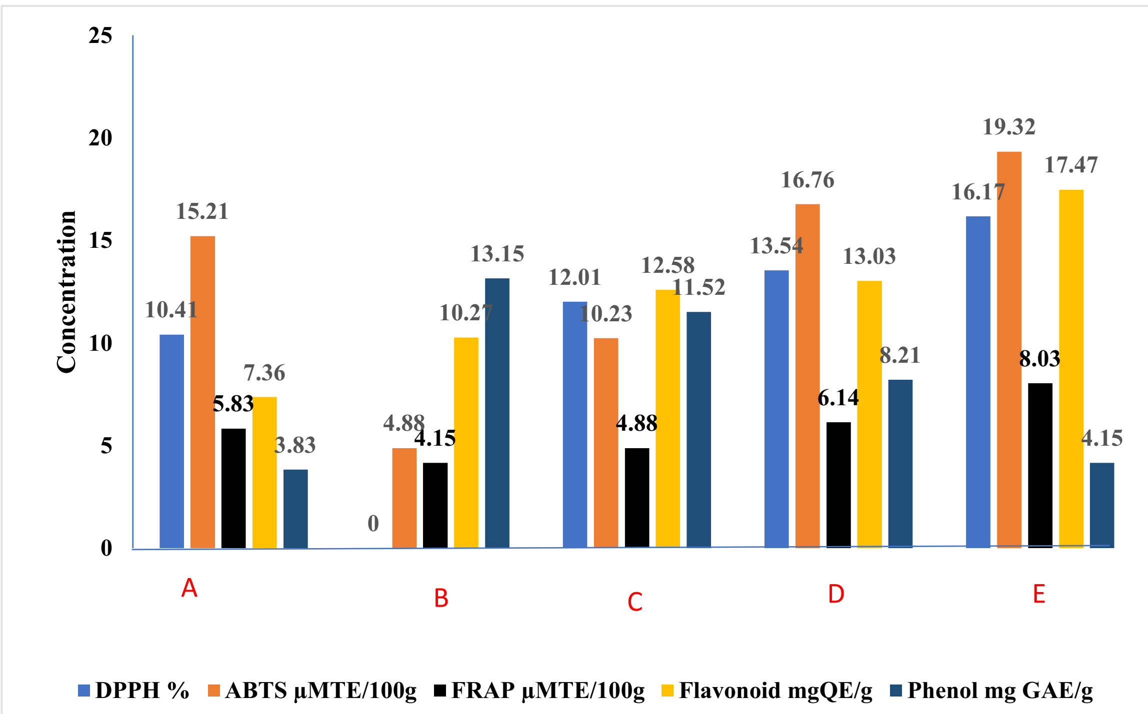

Fig. 1: Antioxidant activity of cow milk and melon seed-coconut milk cheese

Values are the means of duplicate determinations. A=100 % cow milk (CM) cheese, B= MS90:10CC milk cheese, C= MS70:30 milk cheese, D= MS50:50CC milk cheese, E= MS30:70CC milk cheese

Table 7: Correlation coefficient of the antioxidant activity of cow milk and melon seed-coconut milk cheese

	DPPH	ABTS	FRAP	Flavonoid	Phenol
DPPH	1.000				
ABTS	0.854**	1.000			
FRAP	0.900**	0.927**	1.000		
Flavonoid	0.844**	0.471	0.671*	1.000	
Phenol	-0.564	-0.873**	-0.822**	-0.135	1.000

DPPH=Antioxidant capacity measured in DPPH assay, ABTS= Antioxidant capacity measured in ABTS assay, FRAP= Antioxidant capacity measured in FRAP assay, ** significant (p<0.01), * significant (p<0.05)

Table 8: Sensory evaluation of cow milk and melon seed-coconut milk cheese

Sample	Appearance	Taste	Flavour	Texture	General acceptability
A	$7.14^{a}\pm0.14$	$7.35^{a}\pm0.11$	$6.90^{a}\pm0.15$	$7.80^{a}\pm0.09$	$7.45^{a}\pm0.10$
B	$5.10^{e}\pm0.10$	$5.20^{e}\pm0.13$	$6.10^{e}\pm0.10$	$5.40^{e}\pm0.11$	$6.00^{e}\pm0.08$
C	$5.89^{d}\pm0.09$	$6.00^{d}\pm0.08$	$6.51^{bc}\pm0.09$	$6.80^{d}\pm0.11$	$6.55^{d}\pm0.09$
D	$6.24^{c}\pm0.13$	$6.45^{c}\pm0.14$	$6.42^{d}\pm0.11$	$7.00^{c}\pm0.13$	$7.01^{c}\pm0.08$
E	$6.85^{b}\pm0.12$	$6.90^{b}\pm0.13$	$6.50^{bc}\pm0.12$	$7.45^{b}\pm0.16$	$7.10^{b}\pm0.12$

Values are the means of duplicate determinations ± standard deviations. A=100% cheese, B=MS90:10CC cheese, C=MS70:30CC cheese, D=MS50:50CC cheese, E=MS30:70CC cheese