Chemical, Microbiological and Sensory Characteristics of Leather Blends Produced from Mango (*Mangifera indica* 'Ogbomoso') and Carrot (*Daucus carota*)

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Abstract

The postharvest losses in fruits and vegetables in developing countries vary between 15-90%. Many organizations are actively promoting the processing of fruits and vegetables to find a solution to the difficulties encountered in storing large quantities of fresh produce without incurring heavy losses. This study evaluated the chemical, microbiological and sensory properties of leather blends produced from 'Ogbomoso' mango and carrot. Purees of mango (*Mangifera indica* 'Ogbomoso') and carrot (*Daucus carota*) were mixed into five ratios of 100:0%, 75:25%, 50:50%, 25:75%, and 0:100%, mango to carrot ratio. Each blend was then oven-dried at 65°C for 10 hours. Moisture content, crude fat, crude protein, crude fibre, carbohydrate content, vitamin A, vitamin C, titratable acidity, and ash content of the leather blends were determined using standard methods. Sensory characteristics using a 9-point hedonic scale and total mould count of the freshly produced leather blends was determined. Subsequently, 75% leather blend was stored for 60 days at refrigeration (4±1°C) and ambient (28±1°C) temperatures. All data obtained were subjected to ANOVA and means separated using Duncan multiple range test. Crude protein, crude fibre, ash, titratable acidity, vitamin C, vitamin A of the leather blends increased with increase in carrot substitution. No detectable microbial growth was found present in the freshly prepared leather blends. The overall acceptability of the leather blends increased with increase in mango substitution. The leather from 100% carrot was the least acceptable. Crude protein, titratable acid, vitamin A, vitamin C, crude fibre, and crude fat of the 75% mango and 25% carrot leather blend decreased at both storage temperatures. However, greater loss was observed in leather blend stored at ambient temperature. Total mould count after 60 days storage ranged from not detectable to 1.3×10^2 at 4±1°C and 1.5×10^2 at 28±1°C. From the study, blending of 75% mango and 25% carrot could be a suitable method for extending the shelf life of both fruits.

INTRODUCTION

The rapid population growth of Sub-Saharan Africa and progressive urbanization has resulted in increasing rates of malnutrition (IFPRI, 2002) and vitamin deficiency in large sectors of rural and urban populations (WHO, 2002). Fruits and vegetables serves as the cheapest and most accessible source of nutrients necessary for proper growth and development. They provide abundant and cheap source of vitamins, minerals and fibers.

Mango (*Mangifera indica*) is a tropical fruit of mango tree which is not indigenous to Africa, but originated in South-East Asia, from where it was introduced to all other tropical regions. Large quantities of different cultivars of mango are produced annually, each having a distinct colour and flavour. In Nigeria, the cultivar 'Ogbomoso' which belongs to a group of unexploited indigenous fruits is obtained from a local village near Ogbomoso town in the Oyo state. It is eaten in fresh form because of its limited shelf life (Falade and Aworh, 2004). The fruit pulp is sweet, fibrous, rich in a variety of

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phytochemicals, high in prebiotic fibres, vitamin C, polyphenol and pro-vitamin A carotenoids. The mango faces postharvest losses of up to 50% due to high relative humidity, temperature and poor handling techniques and facilities (Aworh and Olorunda, 1981).

Carrot is a known vegetable of great nutritional composition. Carrot has been identified to be free in both saturated and unsaturated fat, low in sodium, free in cholesterol, and a good source of fibre and carotene (Nast, 2012).

Methods have been established to convert gluts of fruits and vegetables into value added products to be sold in urban areas. One of such processing and preservative methods is their conversion into leathers. Leathers are dried food snacks which are sometimes referred to as rolls or roll ups. They are very popular in North American markets and not well known in tropical countries like Nigeria (Babalola et al., 2002). It is manufactured by dehydrating a puree into leather sheet which is eaten as a sauce after reconstitution or as a confection. Many varieties of fruits and vegetables and their blends have been produced into leathers. There is, however, a dearth of information on the chemical, microbiological, sensory characteristics and storage stability of carrot and mango leather blend. This study was, therefore, initiated to develop fruit leathers from different blends of carrot and mango, evaluate their chemical, microbial and sensory characteristics, and study their storage stability at ambient and refrigeration temperatures for a period of 60 days.

MATERIALS AND METHODS

Materials

Matured, ripe mangoes (*Magnifera indica* 'Ogbomoso') and carrots (*Daucus carota*). All chemicals used were of analytical grade.

Methods

1. Production Process of the Mango and Carrot Leather Blends. Mango and carrot purees were prepared separately. The fruits were blanched in hot water at a temperature of 60°C for a period of 2 minutes, allowed to cool, peeled, and pulped into a smooth puree. Mango puree was mixed with carrot puree in the following ratio; 25:75%, 50:50%, and 75:25%. The following blends were poured and spread out evenly on plastic film wrapped tray and placed in an oven. Drying was done at a temperature of 65°C for 10 hours. After drying was achieved, the dried blends were peeled off the trays, cut into quarters, rolled up in a plastic film wrap, and allowed to cool to 35°C before closing up the ends. They were stored at both ambient temperature in cool, dry place and refrigeration temperature.

2. Chemical Analysis. Moisture content, ash, crude protein, crude fat, crude fibre, titratable acidity, vitamins C and A were determined according to AOAC method (2005). Carbohydrate was determined by difference.

3. Microbiological Analysis. Microbial analysis was conducted on the samples (Anon., 1982). The mould count was carried out in duplicate.

4. Sensory Evaluation of Leathers from Mango, Carrot and Their Blends. Coded samples of freshly produced leather samples were served in separate, well-lit cubicles to 40 panellists at room temperature. A descriptive 9-point hedonic scale rating was used to assess leather for colour, aroma, fruitiness, chewiness, sweetness, toughness, and overall acceptability 1 representing like extremely and 9 dislike extremely (Larmond, 1977).

Statistical Analysis

Data obtained were analysed statistically by subjecting them to Analysis of Variance and means separated using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical Composition of Freshly Produced Leather Blends from Mango and Carrot

Table 1 shows the chemical composition of freshly produced leather blends from different ratios of carrot and mango puree. The moisture content of the leather ranged from 15.57% in 25% mango + 75% carrot leather blend to 21.95% in 100% carrot leather, thus the new products are intermediate moisture food (IMF); intermediate moisture foods have a water activity level ranging from 0.65-0.85 and contains 15-30% moisture. The moisture content of the leather samples was significantly different from one another although still within the moisture content range for IMF, 100% carrot leather sample exhibited the highest moisture content. Since the blends were subjected to the same drying process of 65°C for 10 hours using conventional hot-air drying process thus this cannot be possibly responsible for the variation.

The Vitamin A content in all leather samples is considerably high but significantly higher in 100% carrot and 25% mango + 75% carrot leather blends. Table 1 showed that the vitamin A content of each leather sample was increased with increase in carrot content. This could be attributed to the fact that carrot naturally is a good source of beta carotene. Also, a similar trend is noticed in ascorbic acid content of each leather sample even though ascorbic acid is one of the major nutrients in mango juice (Falade et al., 2004). The ascorbic acid content of 100% carrot leather blend was significantly higher than that of the other blends. The low ascorbic acid content observed in 100% mango leather sample may be due to the loss experienced during the processing of fruit leather which involved blanching in water (Che Man and Sin, 1997) to aid peeling of the peel from the fruit (Aina and Adesina, 1990). Ascorbic acid is unstable at high temperature and thus its loss in products indicates the loss of other vitamins and acts as a valid criterion for other sensorial or nutritional components, such as natural pigments and aromatic substances. As the carrot content in each leather blend decreased, the protein and ash content also decreased significantly with the 100% mango leather sample having the lowest protein and ash content. Regardless of this, 100% mango leather blend had the highest carbohydrate content when compared with the other leather blends and the carbohydrate content of the other blend increased with increase in mango content. Thus, it is rich in sugar, yielding considerable number of calories for energy (Sarojini et al., 2009). The 100% carrot leather blend contained significantly high quantity of crude fibre. It was also noted that crude fibre content increased with increase in carrot content in the other blends. The high crude fibre content could be due to the presence of lignin (stone cells), cellulose and hemicelluloses (Ross, 1985; Nawirska and Uklanska, 2008). The 100% carrot leather blend was also significantly high in titratable acid when compared to that of the other leather blends. Apart from improving the keeping quality of leather, the titratable acidity is an important quality factor related to flavour, if the acid level is too low, the product may be bland and unappealing (Chee Man and Sin, 1997). Acidity naturally controls the type of organisms that are able to grow in a product. The 50% mango + 50% carrot leather sample had the highest fat content when compared to the other leather samples. This increased with increase in both carrot and mango content and may be due to reduced moisture content in the leather blends when compared with 100% mango and carrot leathers.

Microbiological Property of Freshly Produced Leather Blends from Mango and Carrot

All leather samples were subject to microbiological analysis in order to determine their total mould count. No growth was detected on the freshly prepared leather blends.

Sensory Properties of Freshly Prepared Leather Blends

The sensory evaluation of freshly produced leather blends are presented in Table 2, the blend with 100% mango and 75% mango + 25% carrot scored significantly higher than the other blends in terms of colour, aroma, fruitiness, chewiness, toughness, and overall acceptability at the beginning of storage. There was no significant difference between the two leather samples with respect to the aforelisted parameters with the exception of sweetness, where the 100% mango leather was significantly higher. Thus the 100% mango leather blend was generally more acceptable. However, amongst the blends, the 75% mango + 25% carrot leather blend was significantly higher with respect to colour, aroma, fruitiness, chewiness, toughness, and overall acceptability. Thus, this percentage of blend is adequate to obtain the most acceptable sensory qualities. The 100% carrot leather sample did not have acceptable sensory characteristics.

Effect of Storage Temperature on the Chemical Composition of Leather Blend Stored for 60 Days under Refrigeration (4°C) and Ambient (28°C) Conditions

The results after 60 days of storage at different storage conditions refrigeration temperature of 4 and 28°C on chemical composition of 75% mango + 25% carrot leather blend are shown in Table 3.

Generally, the protein, ash, vitamins A and C, titratable acidity, fat, and fibre contents of the leather blend decreased with increased storage period.

The retention of vitamin A was found to be higher in the sample stored at 4°C, indicating the adverse effect of temperature on the sample stored at 28°C. Main cause of carotenoid degradation is oxidation and further stimulation by presence of light, enzymes and co-oxidation of carotene (Joseph and Mahadeviah, 1989). The same trend was noticed for ascorbic acid, this might be due to less degradation of ascorbic acid at low temperature as compared to room temperature, as reported by Sagar et al. (1999) in dehydrated ripe mango powder. Refrigeration slows the deterioration of vitamin C. Also, ascorbic acid content decreased with increase in storage period. Many factors affect the stability of ascorbic acid these include temperature, presence of oxygen and light (Jawaheer et al., 2003).

The moisture content of leather blend stored at both refrigeration and ambient temperature were significantly different when compared to that of freshly prepared leather blend. At refrigeration condition, the moisture content of leather blend reduced significantly when compared with that of freshly produced leather blend. This indicates an increase in total solid content of the leather sample. The moisture content of leather blend stored under ambient condition was significantly higher than that stored at refrigeration temperature. This significant increase in moisture content of leather blend that occurred at ambient temperature after 60 days of storage could be due to moisture pick up from the atmosphere (Manimegalai and Ramah, 1998).

There was significant difference in the ash content of leather blend stored at both refrigeration and ambient conditions with that of the latter being significantly higher than that of former. This may be due to difference in moisture content and, also, degradation of vitamins and minerals. The protein content of leather blend decreased with increase in storage period and temperature, this is because protein could be degraded during storage regimes which is usually common at room or ambient temperature (Pinto et al., 1993). Leather blend stored at refrigeration temperature had protein content significantly higher than that stored at ambient temperature.

The titratable acidity of leather blends stored at refrigeration temperature was significantly higher than those of the same leather blend stored at ambient temperature although the titratable acidity decreased with storage period. Also, there was significant difference in the fat contents of leather samples after 60 days of storage. Fat content decreased significantly with increase in storage temperature. Fat may exude with moisture evaporation and ambient temperature seems to enhance this phenomenon.

Effect of Storage Temperature on the Microbiological Composition of Leather Blend Stored for 60 Days under Refrigeration (4°C) and Ambient (28°C) Conditions.

Table 4 shows the microbiological property of leather blend prepared from 75% mango + 25% carrot stored at both refrigeration and ambient temperature. The total mould count of leather blend increased with storage period and temperature when compared with that of freshly prepared leather blend. This could be due to handling practice after production of leather and the presence of sugar which encourages mould growth. Leather blend stored at ambient temperature contained more mould growth than that stored at refrigeration temperature, this is because mould grows better and faster at warm or high temperatures, they can grow at temperatures within the range of 10-35°C while optimum temperatures for growth may range between 15 and 30°C (MBL, 2012). Thus, refrigeration condition is a better storage condition for storing leather samples.

CONCLUSIONS AND RECOMMENDATIONS

Leathers are popular fruit products and have attracted wide attention in developed countries and are gaining grounds in developing countries too. They are high calorie foods retaining the natural vitamins and minerals. This study showed that a blend of carrot and mango purees in the ratio 25% carrot to 75% mango was ideal for the production of satisfactory and acceptable leather blend. Samples of the 75% + 25% carrot leather blend stored at refrigeration temperature of 4°C retained the desired chemical and sensory quality attributes in leather attributes better than samples stored at ambient temperature of 28°C after 60 days of storage. Leather production from mango could solve the problem experienced in storing large quantities of this indigenous fruit without incurring heavy losses. The addition of carrot to mango improved the nutritional attributes of the indigenous fruit.

It is, therefore, recommended that leather blends should be produced from mango and carrot at a ratio of 75% mango to 25% carrot. Further research should be carried out to produce leathers from some other underutilized fruits and vegetables with the same consumer appeal as that of commonly utilized fruits and vegetables.

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Tables

Table 1. Chemical composition of freshly prepared leather blends produced from 'Ogbomoso' mango and carrot.

Parameters (%)	100% C	25 % Ogbomosho mango + 75% carrot	50% Ogbomosho mango + 50% carrot	75% Ogbomosho mango + 25% carrot	100% Ogbomosho mango
Moisture	21.45a	15.57e	20.19c	17.09d	20.97b
Crude protein	[illegible]	5.53b	4.16bc	3.15d	2.55e
Crude fibre	[illegible]	2.16b	1.90c	0.22d	0.16d
Crude fat	3.23d	7.37b	8.56a	4.19c	4.16c
Ash	23.61a	20.01b	14.20c	11.80d	4.13e
Carbohydrate	38.50e	49.36d	50.99c	63.55b	68.03a
Titratable acidity	0.09a	0.06c	0.05c	0.07b	0.05c
Ascorbic acid	15.09a	5.59b	5.28c	3.09d	1.43e
Vitamin A (μg/g)	1811.36a	1595.45ba	1573.06c	1453.41d	1294.32e

Means in the same row followed by the same letter are not significantly different from each other at P≤0.05.

Table 2. Sensory properties of freshly prepared leather blends from 'Ogbomoso' mango and carrot.

Leather sample	Colour	Aroma	Fruitiness	Chewiness	Sweetness	Toughness	Overall acceptability
100% C	4.78c	5.10d	5.13d	5.13d	2.25a	2.80a	5.20d
75% C+ 25%M	3.83b	3.95c	3.63c	3.83b	3.83d	3.80c	4.05c
50% C + 50%M	3.65b	3.55b	3.20b	3.50b	3.40c	3.30b	3.55b
25% C + 75%M	2.85a	2.95a	2.75a	2.73a	2.75b	2.80a	2.60a
100% M	2.60a	2.98a	2.53a	2.70a	2.25a	2.80a	2.60a

Means in the same column followed by the same letter are not significantly different from each other at $P \leq 0.05$ using the Duncan's multiple range test.
C: carrot; M: mango.

Table 3. Effect of storage temperature on the chemical composition of leather blend produced from 75% mango + 25% carrot stored for 2 months at refrigeration (4°C) and ambient (28°C) temperature.

Storage temperature (°C)	Storage period (month)	Protein (%)	Moisture (%)	Ash (%)	Vit. A (µG/G)	Vit. C (%)	Acidity (%)	Fat (%)	Fiber (%)	Cho (%)
	0	3.15a	17.09b	11.80a	1595.45a	3.09a	0.07a	4.19a	0.22a	63.55c
4	2	3.06ab	15.40c	3.04c	1309.86b	2.87b	0.06a	4.01a	0.11a	74.38a
28	2	2.930b	19.57a	4.45b	1181.30c	2.01c	0.03b	3.62b	0.16a	69.27b

Means in the same column followed by the same letter are not significantly different from each other at $P \leq 0.05$ using the Duncan's multiple range test.

Table 4. Effect of storage temperature on the microbiological property of leather blend produced from 75% mango + 25% carrot stored for 2 months at refrigeration and ambient temperature.

Storage temperature (°C)	Storage period (month)	Total mould count (cfu/ml)
	0	No growth
4	2	1.3×10^2
28	2	1.5×10^2