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Effect of Ginger (*Zingiber Officinate*) on Nutritional and Anti-Nutritionalcontents of Some Varities of Mango (*Mangifera Indica*) Fruit Preservation in Gambella Region, Ethiopia.

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Abstract: *Mango is a fruit belongs to the genus Mangifera indica, consisting of numerous species of tropical fruiting trees in the flowering plant family Anacardiaceace. Mango (Mangifera indica) is one of the most important tropical fruits in the world and currently ranked 5th in total world production among the major fruit crops (FAO, 2004). Mango fruit is food. It is very rich in vitamin A and C. It also provides a certain amount of other vitamins and minerals such as riboflavin, niacin, Ca, P and Fe (Jiménez, 2004). Mango pickles preserved in oil and a juice of hot spices to overcome the postharvest loses. Ginger is very important spice/preservative used in mango fruit preservation. The pungent taste of ginger is due to the antimicrobial agent named as gingerols in application for the seek of preservation (Curley and Mark, 1990). Mango fruits sometimes may contain some anti nutrients which are believed to be toxic for human consumption. The anti-nutrients that may be present include lead, cadmium, phytate, oxalate which causes cancer (S. Sarkiyayi et al, 2013). The experiment of this study was laid out in a factorial arrangement of fruits of two mango species (apple mango, and local mango) with one type of preservative (ginger juice) and two methods of drying (sun and oven drying). The study was conducted to assess effect of DMs and pre-treatments on shelf-life, micro-nutrients, anti-nutrients and sensory quality of dried mango fruit. It was conducted in factorial arrangement of 2×1×2 with 2 DMs (sun and oven drying), 1 preservative (ginger juice) and 2 varieties (local and apple) mango fruits laid out in CRD. Fresh fillets were analyzed for proximate analysis, Vit-C, level of anti-nutrients, sensory and microbial quality. Dried samples were stored and analyzed for the expected parameters at 1 month interval and for microbial status every 20 days for 60 days. In fresh samples, a high load of AB of 4.75 log10 cfu/g was observed and mould counts were ND in both the 2 varieties of mango fruits. The MC in fresh fruit (74.68 - 79.14%) whereas high load of AB (4.54-5.38 log10 cfu/g) with (P>0.05) significant difference was observed in untreated fruits of the 2 varieties. Initial load of moulds were <1.31 log10 cfu/g. After 60 days of storage, the maximum load of AB and moulds were 6.56-7.52 and 5.71-6.91 log10 cfu/g, respectively. Vit-C and load of anti-nutritional contents in samples were observed in their appreciable levels. All the parameters under the proximate analysis were vary due to absorption of moisture at ambient condition during the storage time Overall acceptability of treated and untreated samples reached 5.24 (like-slightly) and 4.70 (neither like nor dislike) respectively after 3 months. The total load of AB (7.52 log10 cfu/g) in all untreated samples was the reason that why samples were not allowed for panelists for taste. This was due to the point of sensory rejection in which the number of microbial load should be below the 10^7-10^8 log10 cfu/g (EU 1995). In general, as the storage time of dried fruits increase, there was an increase of microbial population and reduction in acceptability of the products through the storage time. Therefore, hot spices should be applied for preservation purpose to inactivate microbial load and lengthen shelf-life of fruits. The anti-nutrient contents are negligible by international standard. The local mango fruit variety is most recommended for human consumption because of its organic originate and less its susptiblity in contents by microbial contamination.*

Keys: *Mango fruits, hot spices, anti-nutritional contents of mango fruits, Mango fruit preservation, Shelf-life of fruits.*

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I. Introduction

Mango is a fruit belongs to the genus Mangifera indica, consisting of numerous species of tropical fruiting trees in the flowering plant family Anacardiaceace. Mango (Mangifera indica) is one of the most important tropical fruits in the world and currently ranked 5th in total world production among the major fruit crops (FAO, 2004). Mango fruit is food. It is very rich in vitamin A and C. It also provides a certain amount of other vitamins and minerals such as riboflavin, niacin, Ca, P and Fe (Jiménez, 2004). The mango is indigenous to India, cultivated in many tropical and subtropical regions and distributed widely in the world. Mango is used

as food in all stages of its development. Green or unripe mango contains a large portion of starch which gradually changes into glucose, sucrose and maltose as the fruit begins to ripe. It disappears completely when the fruit is fully ripe. The half ripped mango is a valuable source of vitamin C, It contains more vitamin C than half ripe or fully ripe mangoes and it is also a good source of vitamins B1 and B2 and contains sufficient quantity of niacin. These vitamins differ in concentration in various varieties during the stages of maturity and environmental conditions. The ripe fruit is very wholesome and nourishing. The chief food ingredient of mango is sugar; the acids contained in the fruit are tartaric and malic acid, besides a trace of citric acid. Mango contains phenols, this phenolic compound has powerful antioxidant and the antioxidant helps lower a person's risk of developing Alzheimer disease. The antioxidants are naturally occurring substance found in most plant (Godwin and Mercer, 1998). The mango is well-known for its medicinal properties both in unripe and ripe states. The unripe fruit is acidic, astringent and anti scorbutic. The skin of the unripe fruit is astringent and stimulant tonic. The back is also astringent and has a marked action on mucous membranes. Mango pickles preserved in oil and salted solution is used throughout India as food. However, these pickles, if extremely sour, spicy and oily are not good for health and should be specially avoided by those suffering from arthritis, rheumatism, sinusitis, sore throat and hyperacidity. Ginger is very important spice/preservative used in mango fruit preservation. The pungent taste of ginger is due to the antimicrobial agent named as gingerols in application for the seek of preservation (Curley and Mark, 1990). Mango fruits sometimes may contain some anti nutrients which are believed to be toxic for human consumption. The anti-nutrients that may be present include lead, cadmium, phytate, oxalate which cause cancer (S. Sarkiyayi et al, 2013). The objective of this research was to evaluate the effect of ginger on nutritional and anti nutritional contents of two varieties of mangoes (Mangifera indica) namely; apple mango fruit (big fruit mango) and local mango fruit in Gambella Region. The general objective of this research was to study the effects of preservation methods and ginger juice on chemical composition, minerals, anti-nutritional contents, shelf-life and sensory quality of mango fruits preservation. The effect of ginger juice on safety, sensory quality, chemical composition, minerals and ant-nutrients of preserved mango fruits was evaluated. Preservation and preservation methods on chemical composition, minerals, anti-nutrients and shelf life of preserved mango fruits plays a vital role in mango fruit preservation and duration of storage.

II. Materials And Methods

2.1. Description of the Study Area

Harvesting, processing and preservation of mango fruits will be conducted in Abobo and Gambella woreda that located in Gambella Regional State which was at about 777 km in southwest part of Ethiopia from Addis Ababa. It is situated in the lowland of the Baro-Akobo River Basin between latitude 6022' and 8030'N, and longitudes 33010'and 35050' E and it covers a total area of about 34,063 square kilometers, while the total area of the River Basin is about 75,910 km2 (CSA, 2007).

The annual rain fall and mean annual temperature in the region are 1,247mm and 34.370C, respectively (GPNRS, 2011).The rain fall regime is unimodal, referred to as the ''Sudan Type'', occurs in the lowlands along the border with Sudan (Coppock, 1994).The rain fall varies with season, about 60% to 70% occurs during the wet season (i.e., May to October) and 30 to 40% with dry season (November to April). December, January and February are the driest months; only about less than 2% of the annual rainfall occurs in these months over the lowlands of the Region while about 4 to 6% occurs over the highlands (GPNRS, 2011).

2.2. Experimental Location

The mango fruits were collected from Abobo and Gambella Districts in Gambella region where processing, drying, pre-treatments and sensory evaluations were conducted. The analyses for the chemical composition, micro-nutrients and anti-nutrients of fresh and dried mango fruit samples were conducted at Ethiopian Standard Agency (ESA) or Ethiopian Conformity Assessment Enterprise (ECAE) using appropriate instruments/ Addis Ababa and JIJE analytical testing services laboratory. The total microbiological analyses of fresh and dried mango fruit samples like bacterial count (aerobic plate count) and total moulds were conducted in JIJE Analytical Testing Service Laboratory, Addis Ababa and Ethiopia Food microbiology laboratory at four kilo of AAU.

2.3. Experimental Materials

Mango fruit: The experimental materials included two species of mango fruits namely, apple mango or big fruits mango and local mango fruits. After the mango fruits were collected, selections of right quality mangoes were done based on the stage of ripening. The two varieties of mangoes (Mangifera indica) namely; apple mango and local mango fruits were collected from Abobo and Gambella woreda in Gambella regional state. Identification of the mango varieties were authenticated by a herbarium in the Department of Biological Science, Gambella University in Gambella Regional State.

Fig. 1: Apple mango fruit

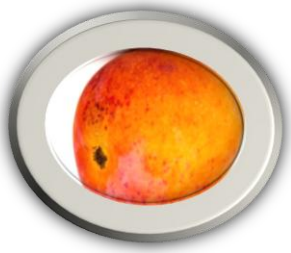

Fig. 2: Local mango fruit

Ginger (*Zingiber officinale*): This was obtained from the local markets at Gambella town. A total of 12 kg ginger was cleaned, washed, and stored in a refrigerator.

Fig. 3: Ginger used as preservative

3.4. Experimental Design and Treatment

The experiment of this study was laid out in a factorial arrangement of 2 x 1 x 2 in a completely randomized design (CRD) with three replications. These were fruits of two mango species (apple mango, and local mango) with one type of preservative (ginger juice) and two methods of drying (sun and oven drying). The controls were fresh and dried fruits of mangoes with no treatment with a total of 12 treatments.

Table 3.1: Experimental planning

Methods	Variety			
	Lm		Am	
	Gi		Gi	
Sun drying	S Gi Lm		S Gi Am	
Oven drying	O Gi Lm		O Gi Am	
Control	Fresh	Dried	fresh	Dried

Where: S (sun drying), O (oven drying), Lm (local mango), Am (apple mango), Gi(ginger).

3.5. Sample Preparation

Mango fruit preparation: The process of fruit preparation was carried out immediately after sufficient experimental fruits were obtained. After the mango fruits were collected, pilling was conducted by cutting the lower belly of the fruit and opened to separate the pill from the mango flesh as a whole based on the following procedures: The whole mango fruits cut into steak (cross-sections taken from flesh). Trimmed the mango fruit steak was cut into flat strips of width x thickness x length of cm, according to FAO (1990 and 2010) standard procedures on sizes suitable for preservation.

Ginger juice preparation: The cleaned ginger was chopped and minced before being used for treatment. Ginger juice was prepared based on FAO (1990 and 2010) for traditional drying of fruits. About 250 mL of distilled water per 1 kg of minced ginger was added and pressed manually to obtain ginger juice dilution. The dilution of ginger juices then was filtered using 4 fold cheese cloths (muslin cloth).The filtrate of ginger juice was collected in air tight bottles and stored in refrigerator at 4oC until used for treatment (Nduagu et al, 2008).

Pre-drying treatment of sliced mango fruits: The steaks of sliced fruit samples about (1000 g) of each sample type was submerged in 1000 mL (1:1 w/v) of ginger juice in flat bowl of 2000 mL capacity (Suleiman, 2010 and Wilson 1981). The steaks of slices of mango fruit lots were uniformly treated in their respective juice by turning them up and dawn for 10 minutes. The treated samples were dried using sun or oven. Another 0.25 kg steak of each sample type was prepared without treatment to be dried in sun, or oven as control (Wilson and Lawrie, 1981). One fourth kg of each of the sample type was stored in deep freeze (-200C) until needed for analysis based on the UK's recommended storage temperature. Every material used for slicing, treatment and

drying activities of the sliced mango fruits was properly cleaned and washed with cold running water followed by washing with hot water.

3.6. Drying of Sliced Mango Fruits

Sun drying: The sliced samples were loaded on flat tin sheet which was constructed on rack for the drying purposes of slices outside in sun. Uniform arrangements of slices were made with no surface contact between the neighboring slices. Each piece of slices of mango fruits was placed at least about 10-15 cm far from the other for good drying. Drying in sun on elevated racks made from wood with flat tin sheets on a top (FAO, 1990 and 2010) and raised about 1 m above the floor allowed air to circulate underneath it. Drying process in sun was conducted until the slice of the fruits was dried to desired level as determined by physical inspection. The whole set up of drying facility allowed to bring indoors overnight and covered properly. After the fruit slices were dried, they were milled and grained using blender and packed in polypropylene plastic bags and stored at room temperature at Gambella District in Gambella regional state. The fresh and dried samples were transported to Addis Ababa for chemical composition, micro-mineral and anti-nutitrtional contents including microbial detections to ensure as food safety.

Oven drying: The oven drying was done with the use of thermostat controlled oven of South African model (model 220). The oven drying temperature to dry the mango fruit slices or samples was adjusted to 125°C for 3 hours based on the recommendations of Food Chemistry Laboratory Manual for fruit samples (Bultosa, 2005). Space of 1-1/2 inches on the sides, front, and back of the trays was allowed so that air can circulate all around them in the oven (AACC, 2000). After the slices mango fruits were dried, they were milled and grained using blender and stored in packed form in water proof plastics (AOAC, 2000).

3.7. Data Collection

3.7.1. Determination of chemical compositions

Determination of crude protein: Crude protein was determined by method described by AOAC (1995). One gramme of each sample was weighed into separated digestion flask and 10 g of a catalyst NaSO4: CuSO4 and 25 mL of concentrated H2SO4 was added. The sample was heated on a micro digestion bench which is thermostatically controlled to remove organic carbon for 2 h. After heating, the content of the flask was left to cool and was transferred to a round bottom flask with distilled water. A little piece of anti bumping granules was added to prevent pumping and 80 mL of 40% NaOH solution was carefully added, mixed and then subjected to distillation until all the ammonia passed over into the standard sulfuric acid solution. It was titrated with standard 0.55 M Na0H solution to an end point. The conversion factor 6.38 was used to get the percentage protein contents.

% crude protein = %N2 x conversion factor

Moisture content: The method described by AOAC (1995) was adopted. The method was based upon the removal of water from the sample and its measurement by loss of weight. A clean crucible was weighed and dried in the oven (W1); 1.0 g of each of the samples was weighed into the crucible (W2) and was dried at 105°C, for twenty four hours. The crucible was then transferred from the oven to desicator, cool and reweighed (W3). The % moisture content was calculated from:

$$\%\ \text{Moisture content} = \frac{W2 - W3}{W2 - W1} \text{x}\ 100$$

Total ash: The AOAC (1995) method was used. The porcelain crucible was dried in an oven at 100°C for 10 min, cooled in a desicator and Weighed (W1). Two grams of the sample was be placed into the previously weighed porcelain crucible and reweighed (w2) and then placed in the furnace for four hours at 600°C to ensure proper ashing. The crucible containing the ash was removed cooled in the desicator and weighed (w3). The % ash content was calculated as:

$$\%\ \text{Ash content} = \frac{W3 - W1}{W2 - W1} \text{x}\ 100$$

Determination of fat: The fat content was determined as in the AOAC (1995). A clean, dried 500 mL round bottom flasks, containing few anti-bumping granules were weighed (w1) and 150 mL of petroleum ether were transferred into the flask fitted with soxhlet extraction apparatus. The round bottom flask and a condenser were connected to the soxhlet extractor and cold water circulation was put on. The heating mantle was switched

on & the heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for 6 h. The round bottom flask & extracted oil were cooled & then weighed (w2).

$$\% \text{ Crude fat content} = \frac{\text{W2} - \text{W1} \ =}{\text{Weight of sample}} \text{ x } 100$$

Determination of crude fibre: The method described by AOAC (1995) was used. 1.0 g of the finely ground sample was weighed out into a round bottom flask, 100 mL of 1.25% Sulphuric acid solution was added and the mixture boiled under a reflux for 30 min. The hot solution was quickly filtered under suction. The insoluble matter was washed several times with hot water until it was acid free. It was quantitatively transferred into the flask and 100 mL of hot 1.25% sodium hydroxide (NaOH) solution was added and the mixture boiled again under reflux for 30 min and quickly filtered under suction. The soluble residue was washed with boiling water until it was base free. It was dried to constant weight in the oven at 105°C, cooled in a desicator and weighed (C1).The weighed sample (C1) was incinerated in a muffle furnace at 300^{o}C for about 30 min, cooled in the desicator and reweighed (C2). The loss in weight of sample on incineration = C1 – C2.

$$\% \text{ Crude fibre} = \frac{\text{C1} - \text{C2}}{\text{Weight of original sample}} \text{ x } 100$$

Determination of carbohydrate: The total carbohydrate content was determined by difference. The sum of the percentage moisture, ash, crude protein and crude fibre were subtracted from 100 (Muller and Tobin, 1980).

Total carbohydrate = 100 - (% moisture + % Ash + % fat + % protein + % fibre).

Determination of mineral elements: One gram of the samples was weighed into the digestion flask of 250 mL capacity a 25 mL of Nitric acid, perchloric and sulphuric acid was be added to each sample. The flask was fixed to a clamp and kept overnight. When the initial reaction subsided, the temperature of the micro-digestion bench was increased slowly from 180°C to 200°C. The digestion was continued at that temperature until no visible particles observe, the temperature was raised up to 240°C and the digestion acid was evaporated until dense white fume formed within the digestion flask. After the digestion was completed, the content of the flask was filtered and the digested material was kept in a dust proof glass chamber. The samples were digested with the disappearance of brown fumes, diluted to 100 mL for AAS Analysis using suitable hallow cathode lamp.

Determination of vitamins C (ascorbic acid) concentration: Hundred gram fresh samples were cut into small pieces and was grinded in a mortal and pestle. Ten mL of distilled water was added several times while grinding the samples and decanting off the liquid extract into a 100 mL volumetric flask. Finally, the ground samples pulp was strain through cheese cloth. The pulp was rinsed with a few 10 mL portions of distilled water and all filtrate and washing was collected in the volumetric flask. The extracted solution was made to 100 mL with distilled water. Five mL of the aliquot sample solution was pipetted into 250 mL conical flask and 20 mL of distilled water, 2 mL of starch indicator solution added to each of the samples. The samples were titrated rapidly with an accurately standardized 0.01N iodine solution containing 16 g potassium iodide per acid. The end point of the titration was identified as the colour changes. Each millititre of iodine is equivalent to 0.88 mg of ascorbic acid, lactone form. The milligram of vitamin C per millitre can be calculated from the relationship, titre value x 0.88 mg.

Determination of oxalate: Oxalate was determined by using the method of Oke (1969). One gram of the sample was placed in a 250 mL volumetric flask, 190 mL of distilled water and 10 mL of 6M HCl was added. The mixture was warmed in a water bath at 90°C for 5 h and the digested sample was centrifuged at a speed of 2,000 rpm for 5 min. Fifty mL aliquots of the supernatant was reduced by evaporation to 25 mL, the brown precipitate was filtered off and washed. The combined solution and washings were titrated with concentrated ammonia solution in drops until salmon pink colour of methyl orange changed to faint yellow. The solution was heated in a water bath to 90°C and the oxalate was precipitated with 10 mL of 5% calcium chloride (CaCl2) solution. The solution was allowed to stand overnight and then centrifuged. The precipitate was washed into a beaker with hot 25% sulphuric acid (H2SO4) diluted with 125 mL with distilled water and after warming to 90°C, it was titrated against 0.05 M KMnO4: 1 ml 0.05M KMnO4 = 2.2 mg oxalate.

Determination of phytate by Reddy (1978): Four gram of the grinded sample was weighed into a beaker and was soaked in 100 mL of 2% HCl for 5 h and then filtered. Twenty five mL of the filtrate was taken into a conical flask; 5 mL of 0.3% potassium thiocynate solution was be added. The mixture was titrated with a standard solution of FeCl3 until a brownish-yellow colour persisted for 5 min. The concentration of the FeCl3 was 1.04%w/v and Mole ratio of Fe to phylate = 1:1.

$$\text{Concentration of phytate phosphorous} = \frac{\text{Titre value x } 0.064}{100 \text{ x weight of sample}}$$

Phytic acid content was calculated on the assumption that it contains 20% P by weight. Determination of cyanide content: Alkaline filtration method of AOAC (1995) was adopted. Ten gram of each grinded sample was soaked in a mixture of 200 mL distilled water and 10 mL of phosphoric acid. The mixture was left for twelve hours to release all bounded Hydrogen Cyanide (HCN) (soaked to dissolve all the cyanide content). A drop of antifoaming agent (tannic acid) and antibumping agent was added and the solution distilled until 150 mL of the distillate was collected, 20 mL of distillate was taken in a conical flask and diluted with 40 mL of distilled water, 8 mL of 6M Ammonium hydroxide and 2 mL of 5% potassium iodide solution was added. The mixture was titrated with 0.02 M silver solution using a micro burette until a faint but permanent turbidity was obtained: $1\text{mL}0.02\text{M}, \text{AgNO3} = 1.08\text{mgHCN}0.2 \text{ x } 1.08 = \frac{\text{Titre value}}{10} \text{ x } 100$

3.7.2. Microbial quality

In this study, microbiological analyses were done to assess APC, EC, and presence of the pathogens like E. coli and Salmonella spp: The load test was conducted on fresh mango fruit slices as well as on dried ones at the beginning of the experiment. Similar tests were conducted on dried slices of mango fruits within 20 up to the storage period of 60 days.

Sampling: In the first microbiological analyses, about 50g of three representative samples of the fresh and freshly dried slices of mango fruits were randomly taken. For the 1st, 2nd and 3rd analyses, about 50g of slices from each of the mango fruit types randomly sampled. Six representative mango fruit slices/ products of fresh in the first analyses and 3 dried samples for each mango fruit types either dried on oven or sun was analyzed before storage. For each of the first, second and third analyses, a total of 6 samples of mango fruits were microbiologically analyzed. In general, overall 30 samples were microbiologically analyzed in this study.

Preparation of serial dilution: Sampling of the product lots for the microbiological analysis were done by aseptically weighing 25g from each sample type and diluting it with 225 mL of bufferd pepetone water (ISO, 2003, method 4833) for preparation of 1:10 dilution level. Samples were homogenized for two minutes using stomacher after placing in the diluents. Decimal dilutions 10^{-2}, 10^{-3} up to 10^{-6} were prepared by transferring 1 mL of the previous dilution (1:10) into test tubes containing 9 mL of 0.1% peptone H2O (ISO, 2003, method 4833). All dilutions were thoroughly mixed before they were platted. Estimated number of colonies per gram of sample was calculated for APC and EC according to Maurine and James (2001) with the formula indicated below:

Formula: $N = \Sigma C / ((1 * n1) + (0.1 * n2)) * V * (d)$

C; was the sum of colonies on all plates to be counted; n1 is the number of plates to be counted at the 1st dilution; n2 is the number of plates to be counted at the 2nd dilution; v is the volume applied in each plate; d is the dilution from which the 1st count obtained.

3.7.2.1. Bacterial count

Detection of presence of the pathogens Escherichia coli and Salmonella spp. were done by taking samples from the dilution level 1:10. Aerobic plate (APC) and Enterbaterceae counts, however, were conducted by taking samples from both 10-5 and 10-6 dilution levels. Total numbers of moulds were counted by taking scraps from the colony counted under APC.

a. Aerobic plate count (APC): was conducted according to ISO (2003) method 4833) using the pour plate technique. The estimation number of colonies per gram of sample was calculated according to Maurine and James (2001).

b. Enumeration of Enterbacteriaceae: was also done according to Maurine and James (2001) with the similar estimation technique to that of APC.

c. Counting of moulds: About 10% of typical colonies grown on APC agar was transferred and plated onto Sabouraud Dextrose Agar Medium. The identification and load of total moulds was estimated based on Libby, Maeda et al and Dagmar (1975, 1997 and 2013) respectively.

3.7.2.2. Detection of pathogens

a. Detection of Escherichia coli: was conducted according to ISO (2006) method 4831 procedures.

b. Detection of Salmonella spp: About 150 mL of representative samples was taken from 1:10 dilution levels, i.e., dilution prepared by adding 25g samples into 225 mL of buffered peptone that was homogenized using stomacher (Libby 1975; Maeda et al 1997 and ISO, 2002, method 6579).

3.7.3. Sensory evaluation
The samples were evaluated using 7 point hedonic scale basis (7= like very much, 6 = like moderately, 5 =like sl ightly, 4 = neither like nor dislike, 3 = dislike slightly, 2 = dislike moderately and 1 = dislike very much) (ES, 20 06, EU, 1995 and Lawless,H.T. and Heymann, H.1998).

3.8. Statistical Analysis: Statistical analyses were conducted on all data collected to test for significance difference among treatment means. ANOVA procedures performed with statistical software (version SAS 9.1) & means was evaluated
at the P<0.05 level of significance using fisher's LSD & Duncan's new multiple range test (Gomez, K.A. & G omez, A .A. 1984).

III. Result And Disscussion

(a) Microbial Analyses

The enumeration of microorganisms (APC and moulds) of the two (local mango and apple mango) varieties of mango fruit pre-treated with ginger was reported as follows. Results revealed that microbial growth was increased through increased storage time. Preserved mango fruit was assumed ''not to be in a good enough condition to be stored for long'' when the aerobic bacteria counts are exceeds 10^6cfu/g (EU, 1995). Aerobic plate counting and total moulds enumeration either in fresh or dried mango fruit were conducted.

Table 1: APC & moulds in fresh mango fruit

Experimental samples	Type of microbial load (log10 cfu/g)	
	Aerobic plate count (APC)	Total mould count
apple mango	4.75 ± 0.01^{a}	ND
local mango	4.47 ± 0.01^{a}	ND

Where, CVt=critical value of t, log10 (logarism in base ten), cfu=colony forming units, CV=coefficient of variances, LSD=least significant differences, ND= not determined and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.
Very few APC with no significant difference and absence of moulds (ND) in fresh samples were reported.

Table 2: Aerobic plate counts of dried samples stored for 60 days

MD	Treat	Spp	Aerobic plate count(log10 cfu/g)			
			Storage period (days)			
			0	20^{th}	40^{th}	60^{th}
SD	C	Lm	5.38 ± 0.08^{d}	6.15 ± 0.47^{ef}	6.61 ± 0.14^{ef}	7.51 ± 0.07^{f}
		Am	5.37 ± 0.06^{d}	5.66 ± 0.06^{bcd}	6.24 ± 0.07^{d}	7.20 ± 0.07^{e}
	Gi	Lm	$4.54\pm.12^{a}$	4.99 ± 0.11^{a}	5.63 ± 0.01^{abc}	6.59 ± 0.01^{ab}
		Am	4.75 ± 0.01^{ab}	5.19 ± 0.07^{a}	5.61 ± 0.05^{abc}	6.56 ± 0.05^{a}
OD	C	Lm	5.27 ± 0.08^{d}	6.04 ± 0.21^{def}	6.50 ± 0.16^{e}	7.52 ± 0.06^{f}
		Am	5.28 ± 0.02^{d}	5.80 ± 0.01^{de}	6.56 ± 0.07^{ef}	7.52 ± 0.07^{f}
	Gi	Lm	4.97 ± 0.06^{bc}	5.36 ± 0.07^{abc}	5.60 ± 0.04^{abc}	6.65 ± 0.04^{bcd}
		Am	4.60 ± 0.06^{a}	4.96 ± 0.07^{a}	5.76 ± 0.13^{c}	6.72 ± 0.13^{d}
Total			4.89 ± 0.31^{a}	5.38 ± 0.40^{b}	5.92 ± 0.41^{c}	6.88 ± 0.40^{d}
CV			2.43	3.40	1.25	0.94
LSD			0.24	0.38	0.15	0.13

Where, LSD= least significant difference, CV=coefficient of variation, Spp. =species, Lm=local mango, Am = aple mango, SD=sun drying, OD=oven drying, C= control), Gi=ginger, log10 =logarism in base ten, cfu =colony forming unit, ND=not determined & the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Significant differences were observed between treated (Gi) and untreated dried samples storage of 60 days. Hence, the lower load of APC in treated samples indicates that the ginger juice has inhibitory effects on growth of microorganisms through drying of mango fruits. However, at the point of sensory rejection, the APC in products could typically be 10^7-10^8 cfu/g.

Table 3: The load of total moulds on dried mango fruits storage

MD	Treat	Spp	Total moulds count (log10 cfu/g)			
			Storage period (days)			
			0	20th	40th	60th
SD	C	Lm	1.22±0.03^{cd}	4.53±0.03^{d}	5.60±0.06^{d}	6.89±0.03^{c}
		Am	1.31±0.04^{d}	4.62±0.04^{d}	5.57±0.04^{d}	6.91±0.08^{c}
	Gi	Am	0.85±0.07^{b}	4.16±0.07^{cd}	5.46±0.07^{c}	6.210.07^{b}
		Lm	ND	2.85±0.04^{a}	3.70±0.04^{a}	5.71±0.04^{a}
OD	C	Am	1.27±0.11^{cd}	4.58±0.11^{d}	5.60±0.01^{d}	6.91±0.02^{c}
		Lm	0.72±0.06^{b}	4.03±0.06^{cd}	5.33±0.06^{c}	6.08±0.06^{ab}
	Gi	Am	0.90±0.14^{b}	4.21±0.14^{cd}	5.51±0.14^{cd}	6.26±0.14^{b}
		Lm	ND	2.88±0.04^{a}	3.73±0.04^{a}	5.74±0.04^{a}
Total			0.35±0.52^{a}	3.32±0.78^{b}	4.30±0.88^{c}	5.99±.47^{d}
CV			28.09	5.43	1.79	2.30
LSD			0.20	0.37	0.16	0.28

Where, LSD= least significant difference, CV=coefficient of variation, Spp. =species, Lm=local mango, Am = aple mango, SD=sun drying, OD=oven drying, C= control), Gi=ginger, log10 =logarism in base ten, cfu =colony forming unit, ND=not determined & the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Significant differences were observed between treated (Gi) and untreated dried samples storage of 60 days.

(b) Acceptability of Samples by customers

Table 5: Acceptability of Fresh and Dried Samples before Storage

DM	Trt	Sp	Color	Odor	Taste	Texture	OA
SD	C	Lm	5.24±0.43^{e}	6.00±0.45^{c}	4.48±0.86^{i}	6±0.45^{ced}	5.98±0.47^{b}
		Am	5.30±0.46^{e}	5.96±0.20^{c}	5.76±0.66^{g}	5.26± 0.44^{f}	5.94±0.24^{b}
	Gi	Lm	6.38±0.64^{c}	6.48±0.65^{ba}	6.46±0.84^{bdac}	6.38±0.78^{b}	6.50± 0.71 ^{a}
		Am	6.50±0.54^{bc}	6.52±0.71^{ba}	6.18±0.96^{edf}	6.22±0.58^{cbd}	6.42±0.67 ^{a}
Fr	C	Lm	6.06 ± 0.31^{d}	6.76 ±0.62^{a}	6.64± 0.72^{a}	6.74±0.49^{a}	6.62±0.60 ^{a}
		Am	6.70±0.58^{a}	6.72±0.57^{a}	6.62±0.67^{ba}	6.74±0.53^{a}	6.62± 0.60 ^{a}
	Gi	Lm	6.48±0.54^{bc}	6.48±0.65^{ba}	6.36 ±1.0^{bdac}	6.28±0.76^{cb}	6.54 ± 0.65^{a}
		Am	6.58±0.54^{ba}	6.58±0.70^{ba}	6.20±0.99^{edcf}	6.22±0.68^{cbd}	6.42±0.73 ^{a}
OD	C	Lm	5.96±0.20^{d}	6.00±0.40^{c}	4.44±0.84^{i}	6±0.40^{ced}	5.92±0.27^{b}
		Am	4.58±0.88^{f}	5.92±0.27^{c}	5.16±0.55^{h}	5.24±0.43^{f}	5.88±0.33^{b}
	Gi	Lm	6.50 ± 0.58^{bc}	6.54±0.65^{ba}	6.36±0.94^{bdac}	6.32±0.79^{b}	6.52±0.65 ^{a}
		Am	6.46±0.61^{dc}	6.50±0.68^{ba}	6.28±0.90^{ebdac}	6.2±0.64^{cbd}	6.40±0.70 ^{a}
CV			8.62	9.22	13.81	9.92	9.49
LSD			0.21	0.23	0.33	0.24	0.24

Where, LSD= least significant difference, trtmnt=treatment, DM=drying method, CV=coefficient of variation, Spp. = species, Lm= local mango, Am= ample mango, C=control samples, SD=sun drying, OD=oven drying and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Significant (P<0.05) differences have been noticed between the treated and untreated samples where as no (P>0.05) variations was observed mostly between the fresh and treated samples of the 2 varieties in all parameters.

Table 2: Effect of treatment combination on sensory score dry fruits after storage of 1 month

DM	Trtmnt	Spp	Color	Odor	Taste	Texture	Overall acceptability
SD	C	Lm	4.88±0.77^{c}	5.22±0.51^{b}	3.56±1.03^{g}	4.92±0.50^{bdc}	5.30±0.46^{b}
		Am	4.94±0.82^{c}	5.18±0.39^{b}	4.84±0.68^{e}	4.28± 0.27^{e}	5.26±0.44^{b}
	Gi	Lm	5.98±0.82^{a}	5.70±0.61^{a}	5.44±0.91^{ba}	5.34±0.69^{a}	5.74±0.49 ^{a}
		Am	6.16±0.68^{a}	5.76±0.62^{a}	5.36±0.96^{bac}	5.20±0.64^{bdac}	5.80± 0.40 ^{a}
OD	C	Lm	5.60±0.49^{b}	5.22±0.46^{b}	3.52±0.97^{g}	5.02±0.43^{bdc}	5.24±0.43^{b}
		Am	4.22±1.20^{d}	5.14±0.45^{b}	4.24±0.69^{f}	4.26±0.44^{e}	5.20±0.40^{b}
	Gi	Lm	6.14 ± 0.73^{a}	5.76±0.59^{a}	5.44±0.93^{ba}	5.34±0.80^{a}	5.84±0.42 ^{a}
		Am	6.10±0.74^{a}	5.72±0.67^{a}	5.36±0.92^{bac}	5.22±0.62^{bac}	5.72±0.50 ^{a}
CV			12.60	11.33	17.20	12.29	8.60
LSD			0.29	0.24	0.34	0.25	0.19

Where, LSD= least significant difference, trtmnt=treatment,
DM=drying method,CV=coefficient of variation, Spp. = species, Lm= local mango, Am= ample mango, C=control samples, SD=sun drying, OD=oven drying and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Table 3: Sensory acceptability test results of dried fruits after the storage of two months.

DM	Trtmnt	Spp	Color	Odor	Taste	Texture	Overall acceptability
SD	C	Lm	4.68±1.06^{e}	4.92±0.70^{b}	3.40±1.17^{g}	4.64±0.56^{bac}	5.04±0.67^{b}
		Am	4.74±1.10^{e}	4.88±0.69^{b}	4.68±0.74^{e}	3.90± 0.84^{d}	5.00±0.73^{b}
	Gi	Lm	5.78±1.09^{bdac}	5.40±0.78^{a}	5.28±0.90^{ba}	4.96±0.78^{ba}	5.46±0.58 ^{a}
		Am	5.96±0.90^{a}	5.46±0.79^{a}	5.20±1.03^{bac}	4.82±0.80^{bac}	5.52± 0.68 ^{a}
OD	C	Lm	5.40±0.81^{dc}	4.92±0.67^{b}	3.36±1.12^{g}	4.64±0.56^{bac}	4.98±0.71^{b}
		Am	4.02±1.45^{f}	4.84±0.71^{b}	4.08±0.80^{f}	3.88±0.80^{d}	4.94±0.68^{b}
		Cr	4.72±1.09^{e}	4.82±0.72^{b}	4.80 ± 0.70^{edc}	4.58±0.54 ^{bc}	5.00± 0.73^{b}
	Gi	Lm	5.94 ± 0.98^{a}	5.46±0.79^{a}	5.28±0.90^{ba}	4.96±0.90^{ba}	5.56±0.58 ^{a}
		Am	5.90±0.99^{a}	5.42±0.86^{a}	5.20±0.96^{bac}	4.84±0.77^{bac}	5.44±0.70 ^{a}
CV			17.63	15.74	18.85	17.09	12.89
LSD			0.39	0.32	0.36	0.32	0.27

Where, LSD= least significant difference, trtmnt=treatment,
DM=drying method,CV=coefficient of variation, Spp. = species, Lm= local mango, Am= ample mango, C=control samples, SD=sun drying, OD=oven drying and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Table 8: Sensory Acceptability of Dried mango fruits after Storage of 3 Months

DM	Trt	Sp	Color	Odor	Texture	OA
SD	C	Lm	4.26±0.78^{c}	4.50±0.65^{b}	4.32±0.74^{cd}	4.74±0.63^{b}
		Am	4.32±0.79^{c}	4.46±0.50^{b}	3.58± 0.54^{d}	4.70±0.46^{b}
	Gi	Lm	5.36±0.98^{a}	4.98±0.77^{a}	4.62±0.85^{a}	5.14±0.70 ^{a}
		Am	5.54±0.84^{a}	5.04±0.78^{a}	4.48±0.76^{ba}	5.20± 0.64 ^{a}
OD	C	Lm	5.98±0.68^{b}	4.50±0.58^{b}	4.32±0.71^{bc}	4.68±0.47^{b}
		Am	3.60±1.09^{d}	4.42±0.57^{b}	3.56±0.50^{d}	4.64±0.48^{b}
	Gi	Lm	5.52 ± 0.91^{a}	5.04±0.78^{a}	4.62±0.88^{a}	5.24±0.66 ^{a}
		Am	5.48±0.95^{a}	5.00±0.83^{a}	4.52±0.71^{ba}	5.14±0.67 ^{a}
CV			16.83	15.58	17.64	13.16
LSD			0.34	0.29	0.3	0.26

Where, LSD= least significant difference, trt=treatment, DM=drying method,CV=coefficient of variation, Spp. = species, Lm= local mango, Am= ample mango, C=control samples, SD=sun drying, OD=oven drying and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Panelist found or preferred most of the flavor of the ginger treated mango samples. The products were lead to point of sensory rejection of 107-108 cfu/g after 40 days storage period (EU, 1995). From the scores, the panelist detected rancid odor almost in all the control samples. The overall acceptability scores decreased while the storage time increased in all the samples and this agrees with the findings of Idris et al. (2010).

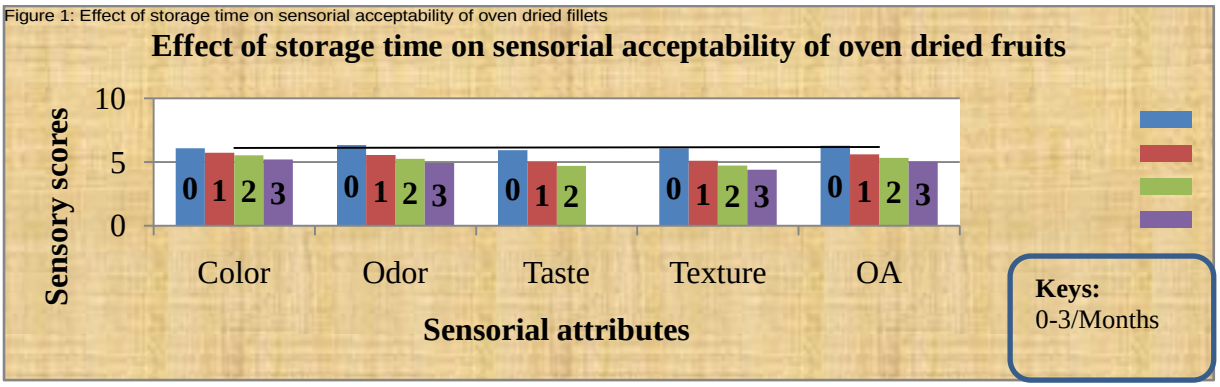

Figure 1: Effect of storage time on sensorial acceptability of oven dried fillets

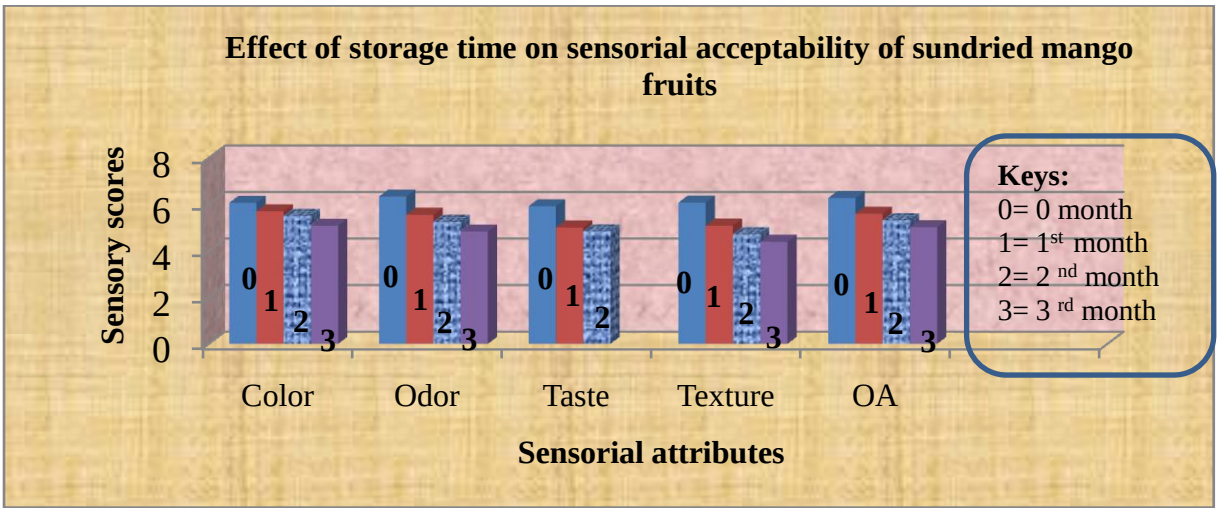

Figure 1: Effect of storage on sensorial acceptability of sundried mango fruits

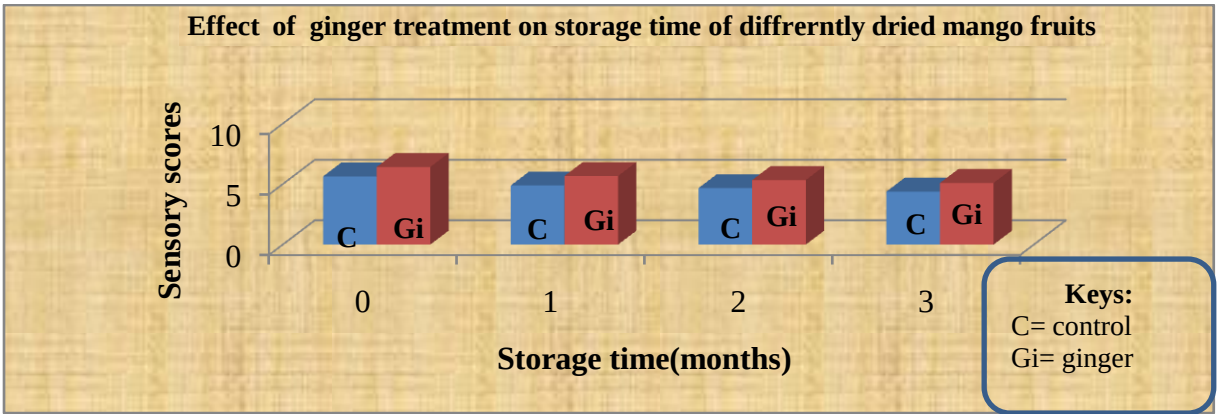

Figure 3: Effect of ginger treatment on storage of dried mango

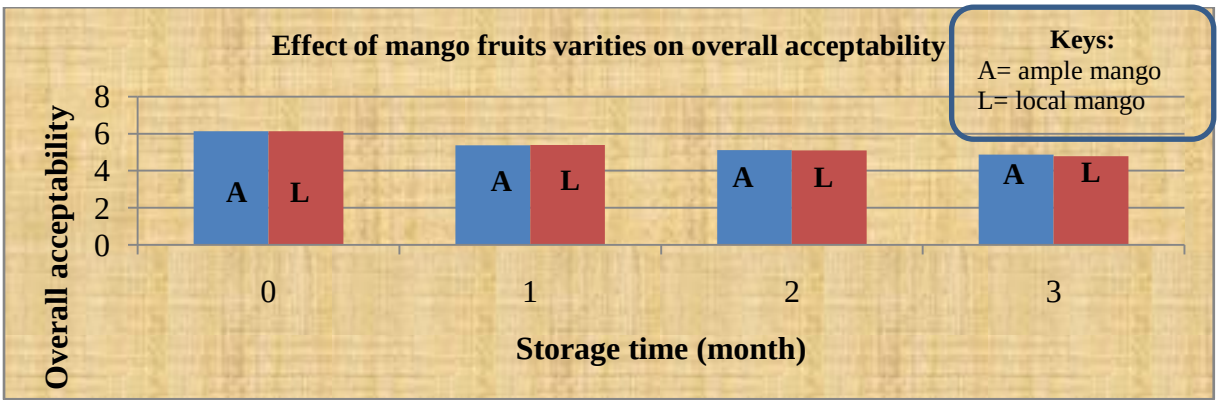

Figure 4: Effect of mango fruits varieties storage on overall acceptability

(c) Proximate analysis and ant-nutritional contents in fresh samples.

Table 4: Proximate analysis and ant-nutritional contents in fresh samples

Sam	Sp	MC (%)	Ash (%)	Prot (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100)	Phyt (100)	CN (100g
Fr	Am	79.14±4.29^{a}	2.67±0.23^{a}	2.24±0.04^{a}	0.38±0.06^{a}	2.97±0.07^{a}	12.6±10.63^{bc}	62.78±10.91^{a}	190.81±11.73^{a}	0.89±0.32^{ab}	0.63±0.02^{a}	0.23±0.03^{a}
Gi	Am	78.56±6.60^{a}	2.26±0.28^{a}	2.22±0.33^{a}	0.49±0.16^{a}	2.92±0.10^{a}	13.55±6.40^{b}	67.49±6.60^{a}	179.28±1.80^{a}	0.60±0.06^{a}	0.60±0.05^{a}	0.24±0.02^{a}
Fr	Lm	74.68±5.41^{c}	2.49±0.38^{a}	2.23±0.11^{a}	0.45±0.08^{a}	3.03±0.03^{a}	17.12±5.78^{a}	81.45±5.41^{a}	196.01±7.06^{a}	1.42±0.13^{b}	0.58±0.04^{a}	0.24±0.02^{a}
Gi	Lm	77.99±7.80^{ab}	2.01±0.03^{a}	2.26±0.06^{a}	0.44±0.15^{a}	2.88±0.06^{a}	14.42±7.98^{b}	70.68±7.80^{a}	180.18±1.66^{a}	1.39±0.33^{b}	0.56±0.06^{a}	0.19±0.01^{a}

Where, LSD= least significant difference, CV= coefficient of variation, Spp. =species, Vit-C=vitamine C, Am=aple mango, Lm= local mango, Fr=fresh, Gi=ginger and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

United states standard	Year	Standard Level
Anti-nutrients	2015	40-50mg /day (Free from Kidney Stones)
Vitamin-C	2006	< 2 g/day
Moisture content	2000	50-86%
Carbohydrate (g/100g)	-	7-20

Table 5: Proximate analysis and ant-nutritional values of fresh and dried mango fruit samples

Sam	Sp	MC (%)	Ash (%)	Prot (%)	Fat (%)	Fiber (%)	CHO (%)	Energy(cal)	Vit-C (100g)	Ox (100)	Phyt (100)	CN (100g
Fr	Am	79.14±4.29^{a}	2.67±0.23^{a}	2.24±0.04^{a}	0.38±0.06^{a}	2.97±0.07^{a}	12.6±10.63^{d}	62.78±10.91^{b}	190.81±11.73^{a}	0.89±0.32^{ab}	0.63±0.02^{a}	0.23±0.03^{a}
	Lm	74.68±6.60^{ab}	2.26±0.28^{a}	2.22±0.33^{a}	0.49±0.16^{a}	2.92±0.10^{a}	17.12±6.40^{c}	81.45±6.60^{a}	179.28±1.80^{a}	0.60±0.06^{a}	0.60±0.05^{a}	0.24±0.02^{a}
Dr	Lm	10.68±5.41^{c}	2.49±0.38^{a}	2.23±0.11^{a}	0.45±0.08^{a}	3.03±0.03^{a}	51.13±5.78^{ab}	59.33±5.41^{c}	196.01±7.06^{a}	1.42±0.13^{b}	0.58±0.04^{a}	0.24±0.02^{a}
	Am	11.99±7.80^{c}	2.01±0.03^{a}	2.26±0.06^{a}	0.44±0.15^{a}	2.88±0.06^{a}	53.43±7.98^{a}	61.01±7.80^{b}	180.18±1.66^{a}	1.39±0.33^{b}	0.56±0.06^{a}	0.19±0.01^{a}

Where, LSD= least significant difference, CV= coefficient of variation, Spp. =species, Vit-C=vitamine C, Am=aple mango, Lm= local mango, Fr=fresh, Gi=ginger and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

High significant differences were seen between dried & fresh mango fruits due to the reduction of moisture content in dried samples after drying. Values were similar to fat (0.02-2), protein (0.5-8), ash (0.5-10) & fiber (0.5-20) of most researchers reports (US 2015).

Table 6: Proximate analysis and ant-nutritional values of dried mango fruit samples

MD	Spp.	MC (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100g)	Phy (100g)	Cy (100g)
OD	Am	7.50±1.00[a]	2.25±0.50[a]	2.00±0.00[a]	0.00±0.00[a]	2.80±0.55[a]	84.94±0.65[a]	350.82±1.97[a]	189.75±9.07[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
	Lm	8.00±0.82[a]	2.25±0.50[a]	2.00±0.00[a]	0.00±0.00[a]	2.68±0.46[a]	84.82±0.90[a]	350.18±3.10[a]	181.69±5.40[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
SD	Am	7.75±0.50[a]	2.00±0.00[a]	2.00±0.00[a]	0.50±0.58[a]	2.79±0.53[a]	84.60±0.94[a]	352.10±3.29[a]	182.75±11.24[a]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]
	Lm	9.50±1.29[a]	2.00±0.00[a]	2.00±0.00[a]	0.50±0.58[a]	2.95±0.21[a]	82.84±1.19[a]	344.89±5.23[a]	149.76±35.14[a]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]

Where, LSD= least significant difference, CV= coefficient of variation, Spp. =species, Vit-C=vitamine C, Am=apple mango, Lm= local mango, and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Table 13: Proximate analysis and ant-nutritional values of preservatives interaction with MD of mango fruit samples

MD	T	MC (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (cal)	Energy (cal)	Vit-C (100g)	Ox (100g)	Pyh (100g)	Cy (100g)
OD	C	8.25±0.96[a]	2.50±0.58[a]	2.00±0.00[a]	0.00±0.00[b]	2.50±0.58[a]	84.50±0.58[a]	349.00±2.45[a]	183.75±7.37[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
	Gi	7.25±0.50[a]	2.00±0.00[a]	2.00±0.00[a]	0.00±0.00[b]	2.98±0.19[a]	85.26±0.73[a]	352.00±1.32[a]	187.69±9.49[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
SD	C	8.25±1.26[a]	2.00±0.00[a]	2.00±0.00[a]	0.75±0.50[a]	2.81±0.55[a]	84.14±1.52[a]	350.72±5.91[a]	162.75±30.42[b]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]
	Gi	9.00±1.41[a]	2.00±0.00[a]	2.00±0.00[a]	0.25±0.50[ba]	2.93±0.18[a]	83.30±1.25[a]	346.27±4.98[a]	169.76±33.59[ba]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]

Where, LSD= least significant difference, CV= coefficient of variation, Spp. =species, Vit-C=vitamine C, Am=aple mango, Lm= local mango, and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

Table 14: Proximate analysis and ant-nutritional values of preservatives interaction with MD of mango fruit samples

MD	T	MC (%)	Ash (%)	Prot (%)	Fat (%)	Fibr (%)	CHO (cal)	Energy (cal)	Vit-C (100g)	Ox (100g)	Phyt (100g)	CN (100g)
OD	C	8.25±0.96[a]	2.50±0.58[a]	2.00±0.00[a]	0.00±0.00[b]	2.50±0.58[a]	84.50±0.58[a]	349.00±2.45[a]	183.75±7.37[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
	Gi	7.25±0.50[a]	2.00±0.00[a]	2.00±0.00[a]	0.00±0.00[b]	2.98±0.19[a]	85.26±0.73[a]	352.00±1.32[a]	187.69±9.49[a]	0.75±0.50[a]	0.54±0.04[a]	0.19±0.02[a]
SD	C	8.25±1.26[a]	2.00±0.00[a]	2.00±0.00[a]	0.75±0.50[a]	2.81±0.55[a]	84.14±1.52[a]	350.72±5.91[a]	162.75±30.42[b]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]
	Gi	9.00±1.41[a]	2.00±0.00[a]	2.00±0.00[a]	0.25±0.50[ba]	2.93±0.18[a]	83.30±1.25[a]	346.27±4.98[a]	169.76±33.59[ba]	1.25±0.50[a]	0.50±0.04[a]	0.17±0.03[a]

Significant (P<0.05) differences were seen in fat content between the two methods of drying. The values of anti-nutrients were below the risk under standard requirement stated by Food Technologists.

Table 15: Proximate analysis and ant-nutritional values of dried mango fruits before storage.

DM	T	Sp	MC (%)	Ash (%)	Prot (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100g)	Phyt (100g)	CN (100g)
OD	C	A	10.00±1.41[b]	2.50±0.71[a]	2.00±0.00[a]	0.00±0.00[b]	2.50±0.71[a]	82.50±0.71[a]	342.00±2.83[a]	183.50±9.19[a]	0.50±0.71[a]	0.47±0.02[a]	0.20±0.07[a]
	Gi	A	8.00±0.00[a]	2.00±0.00[a]	2.00±0.00[a]	0.00±0.00[b]	2.95±0.32[a]	85.00±0.00[a]	349.50±0.71[a]	189.00±12.73[a]	1.00±0.00[a]	0.53±0.01[a]	0.18±0.04[a]
SD	C	A	8.50±0.71[b]	2.00±0.00[a]	2.00±0.00[a]	1.00±0.00[a]	2.50±0.71[a]	84.50±0.71[a]	351.00±4.24[a]	173.00±16.97[a]	1.00±0.00[a]	0.46±0.06[a]	0.13±0.00[a]
	Gi	A	8.00±0.00[ba]	2.00±0.00[a]	2.00±0.00[a]	0.00±0.00[b]	3.08±0.10[a]	84.00±0.00[a]	349.00±1.41[a]	183.50±7.78[a]	1.00±0.00[a]	0.48±0.03[a]	0.18±0.02[a]

OD	C	L	10.00±1.41^{b}	2.00±0.00^{a}	2.00±0.00^{a}	0.00±0.00^{b}	2.50±0.71^{a}	83.00±1.41^{a}	342.50±6.36^{a}	181.00±8.49^{a}	1.00±0.00^{a}	0.55±0.02^{a}	0.15±0.07^{a}
	Gi	L	8.00±0.00^{a}	2.00±0.00^{a}	2.00±0.00^{a}	0.00±0.00^{b}	2.82±0.04^{a}	85.00±1.41^{a}	350.50±2.12^{a}	175.02±7.09^{a}	1.00±0.00^{a}	0.50±0.07^{a}	0.19±0.02^{a}
SD	C	L	9.50±2.12^{b}	2.00±0.00^{a}	2.00±0.00^{a}	0.50±0.71^{ba}	3.16±0.05^{a}	83.50±2.12^{a}	345.50±9.19^{a}	145.50±43.13^{a}	1.00±0.00^{a}	0.48±0.04^{a}	0.09±0.10^{a}
	Gi	L	11.00±1.41^{a}	2.00±0.00^{a}	2.00±0.00^{a}	0.50±0.71^{ba}	2.68±0.06^{a}	82.00±1.41^{a}	339.50±4.95^{a}	149.86±44.11^{a}	1.00±0.00^{a}	0.47±0.08^{a}	0.13±0.03^{a}

The MC content did show significant (P>0.05) difference between ginger treated dried and untreated samples at the end of drying operation. No risk of anti-nutrients in all the samples was seen. Similar results were reported by S. Sarkiyayi et al. (2013).

Table 16: Proximate analysis and ant-nutritional values of dried mango fruits after the storage of one month.

DM	T	Sp	MC (%)	Ash (%)	Prot (%)	Fat (%)	Fibr (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100g)	Phyt (100g)	CN (100g)
OD	C	A	11.00±1.41^{ba}	2.50±0.71^{ba}	2.16±0.00^{ab}	0.30±0.00^{b}	2.03±0.45^{ba}	82.01±0.71^{bc}	339.38±2.83^{bc}	173.43±9.11^{ab}	0.00±0.00^{a}	0.35±0.21^{ba}	0.10±0.11^{a}
	Gi	A	8.50±0.71^{b}	3.00±0.00^{a}	2.00±0.00^{b}	1.10±0.00^{a}	2.59±0.29^{ba}	82.81±0.00^{bc}	349.14±0.71^{ba}	183.11±5.66^{a}	0.50±0.71ba	0.47±0.02^{ba}	0.09±0.01^{a}
SD	C	A	9.50±0.71^{ba}	1.69±0.00^{c}	1.97±0.00^{b}	0.50±0.71^{ab}	1.89±0.43^{b}	84.45±0.71^{b}	350.18±4.24^{a}	169.11±14.14^{ab}	1.00±0.00^{b}	0.35±0.08^{a}	0.00±0.00^{a}
	Gi	A	8.50±0.71^{b}	2.00±0.00^{b}	2.10±0.00^{b}	0.13±0.00^{bc}	2.74±0.06^{a}	84.53±0.00^{b}	347.69±1.41^{ba}	146.11±1.41^{a}	1.00±0.00^{b}	0.40±0.01^{ba}	0.09±0.01^{a}
OD	C	L	11.00±1.41^{ba}	2.80±0.00^{a}	2.00±0.00^{b}	0.00±0.00^{b}	2.31±0.62^{ba}	81.89±1.41^{c}	335.56±6.36^{c}	174.11±7.07^{ab}	0.50±0.71ba	0.38±0.11^{ba}	0.11±0.07^{a}
	Gi	L	8.50±0.71^{b}	2.00±0.00^{b}	2.12±0.00^{ab}	0.00±0.00^{b}	2.38±0.08^{ba}	87.38±1.41^{a}	358.00±2.12^{a}	180.13±5.67^{a}	0.00±0.00^{a}	0.36±0.07^{b}	0.29±0.28^{a}
SD	C	L	10.00±1.41^{ba}	1.90±0.00^{bc}	2.00±0.00^{b}	0.00±0.00^{b}	2.79±0.00^{a}	83.31±2.12^{bc}	341.24±9.19^{b}	142.61±47.38^{b}	1.00±0.00^{b}	0.40±0.01^{ba}	0.05±0.04^{a}
	Gi	L	12.00±1.41^{a}	2.00±0.00^{b}	2.31±0.00^{a}	1.00±0.00^{a}	2.21±0.14^{ba}	80.48±1.41c	340.16±4.95^{b}	169.97±41.28^{ab}	1.00±0.00^{b}	0.37±0.14^{ba}	0.08±0.00^{a}

Where, LSD= least significant difference, CV=coefficient of variation, DM=drying method, Sp. =species, Vit-C=vitamine C, A=apple mango, L= local mango, and the values are mean ±SD at 5% level of significance.

Significant (P>0.05) differences in nutritional values between treated and untreated dried samples observed. All the parameters were slightly increased with no statistical variation except anti-nutrients after 1 month storage. Furthermore, Significant (P>0.05) differences in MC between C and Gi juice treated samples. The fact is that the compositions of treated samples were in combination of the samples to with that of juices make the values higher than those of untreated samples.

Table 17: Proximate analysis and ant-nutritional values of dried mango fruits after the storage of two months.

DM	Treatment	Sp	MC (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100g)	Pyt (100g)	Cy (100g)
OD	C	A	9.7±1.41^{a}	1.79±0.71^{c}	4.43±0.00^{a}	1.44±0.00^{a}	3.03±0.45^{a}	79.61±0.71^{b}	349.12±2.83^{a}	162.53±9.11^{b}	0.01±0.00^{a}	0.41±0.21^{ba}	0.11±0.11^{a}
	Gi	A	9.81±0.71^{a}	3.33±0.00^{a}	2.26±0.00^{bc}	0.61±0.00^{b}	2.59±0.29^{ba}	81.4±0.00^{ba}	340.13±0.71^{ba}	175.11±5.66^{a}	0.60±0.71^{ba}	0.46±0.02^{ba}	0.10±0.01^{a}
SD	C	A	10.5±0.71^{ba}	2.21±0.00^{b}	2.44±0.00^{bc}	0.35±0.71^{bc}	2.1±0.43^{c}	82.4±0.71^{ba}	342.51±4.24^{ba}	166.01±14.14^{b}	1.01±0.00^{b}	0.33±0.08^{a}	0.01±0.00^{a}
	Gi	A	12.11±0.71^{b}	2.9±0.00^{ba}	2.9±0.00^{b}	0.11±0.00^{c}	3.06±0.06^{a}	78.92±0.00^{b}	328.27±1.41^{b}	142.11±1.41^{c}	1.10±0.00^{b}	0.41±0.01^{ba}	0.08±0.01^{a}
OD	C	L	9.6±1.41a	2.00±0.00^{bc}	2.12±0.00^{c}	0.01±0.00^{c}	2.52±0.62^{b}	83.75±1.41^{a}	343.57±6.36^{ba}	170.11±7.07^{ab}	0.51±0.71^{ba}	0.39±0.11^{ba}	0.12±0.07^{a}
	Gi	L	8.50±0.71^{b}	2.01±0.00^{b}	2.12±0.00^{c}	0.00±0.00^{c}	2.49±0.08^{b}	84.88±1.41^{a}	348.00±2.12^{a}	171.13±5.67^{ab}	0.02±0.00^{a}	0.37±0.07^{b}	0.27±0.28^{a}
SD	C	L	11.00±1.41^{ba}	1.90±0.00^{bc}	2.01±0.00^{c}	0.12±0.00^{c}	3.01±0.00^{a}	81.96±2.12^{ba}	336.96±9.19^{b}	122.61±47.38^{d}	1.05±0.00^{b}	0.44±0.01^{ba}	0.03±0.04^{a}
	Gi	L	12.12±1.41^{b}	2.13±0.00^{b}	3.44±0.00^{a}	1.14±0.00^{ba}	2.45±0.14^{b}	78.72±1.41^{b}	338.9±4.95^{b}	160.07±41.28^{ab}	1.11±0.00^{b}	0.37±0.14^{ba}	0.06±0.00^{a}

Where, LSD= least significant difference, CV=coefficient of variation, DM=drying method, Spp. =species, Vit-C=vitamine C, A=aple mango, L= local mango, and the values are mean ±SD in that the mean values followed by the same letter in a column are not significantly different at 5% level of significance.

All the micro-nutrients stated after storage of two months showed that slightly reduction in contents due to the moisture absorption at the time of storage at ambient condition. However, the content of antinutrients showed slight variation after the storage of two month.

Table 18: Proximate analysis and ant-nutritional values of dried mango fruits after the storage of three months.

DM	Treatment	Sp	MC (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (cal)	Vit-C (100g)	Ox (100g)	Pyt (100g)	Cy (100g)
OD	C	A	9.91±1.41^{ba}	1.88±0.71^{e}	4.33±0.00^{a}	1.05±0.00^{ba}	2.9±0.45^{a}	79.93±0.71^{b}	346.49±2.83^{a}	152.53±9.11^{b}	0.02±0.00^{a}	0.40±0.21^{ba}	0.10±0.11^{a}
	Gi	A	10.02±0.71^{ba}	3.23±0.00^{b}	2.3±0.00^{c}	0.55±0.00^{b}	2.5±0.29^{bc}	81.4±0.00^{ba}	339.75±0.71^{b}	161.13±5.66^{ab}	0.57±0.71^{ba}	0.44±0.02^{ba}	0.12±0.01^{a}
SD	C	A	10.71±0.71^{ba}	2.22±0.00^{c}	2.47±0.00^{c}	0.33±0.71^{bc}	2.01±0.43^{c}	82.26±0.71^{ba}	341.89±4.24^{ba}	160.01±1.14^{ab}	1.11±0.00^{b}	0.31±0.08^{a}	0.03±0.00^{a}
	Gi	A	12.32±0.71^{c}	2.87±0.00^{bc}	3.01±0.00^{bc}	0.14±0.00^{cd}	3.0±0.06^{a}	78.66±0.00^{b}	327.94±1.41^{bc}	141.12±1.41^{c}	1.11±0.00^{b}	0.38±0.01^{ba}	0.06±0.01^{a}
OD	C	L	9.81±1.41^{ba}	2.25±0.00^{c}	2.13±0.00^{cd}	0.04±0.00^{d}	2.5±0.62^{bc}	83.27±1.41^{a}	341.96±6.36^{ba}	140.10±7.07^{c}	0.53±0.71^{ba}	0.35±0.11^{ba}	0.11±0.07^{a}
	Gi	L	8.71±0.71^{a}	2.05±0.00^{d}	2.11±0.00^{cd}	0.5±0.00^{b}	2.48±0.08^{bc}	84.15±1.41^{a}	349.54±2.12^{a}	169.10±5.67^{a}	0.04±0.00^{a}	0.32±0.07^{b}	0.26±0.28^{a}
SD	C	L	11.21±1.41^{bc}	2.05±0.00^{d}	1.99±0.00^{d}	0.21±0.00^{c}	2.98±0.00^{a}	81.56±2.12^{ba}	336.09±9.19^{bc}	120.63±4.24^{d}	1.07±0.00^{b}	0.34±0.01^{ba}	0.02±0.04^{a}
	Gi	Lm	12.33±1.41^{a}	12.14±0.00^{a}	3.34±0.00^{b}	1.22±0.00^{a}	2.5±0.14^{bc}	68.47±1.41^{c}	298.22±4.95^{c}	158.06±4.24^{ab}	1.15±0.00^{b}	0.36±0.14^{ba}	0.07±0.00^{a}

Where, LSD= least significant difference, CV=coefficient of variation, DM=drying method, Sp. =species, Vit-C=vitamine C, A=aple mango, L= local mango, and the values are mean ±SD at 5% level of significance.

Steady increasing trends of MC were observed up to the 3rd month storage.

IV. Summary

The study was conducted to assess effect of DMs and pre-treatments on shelf-life, micro-nutrients, anti-nutrients and sensory quality of dried mango fruit. It was conducted in factorial arrangement of 2×1×2 with 2 DMs (sun and oven drying), 1 preservative (ginger juice) and 2 varieties (local and apple) mango fruits laid out in CRD. Fresh fillets were analyzed for proximate analysis, Vit-C, level of anti-nutrients, sensory and microbial quality. Dried samples were stored and analyzed for the expected parameters at 1 month interval and for microbial status every 20 days for 60 days. In fresh samples, a high load of AB of 4.75 log10 cfu/g was observed and mould counts were ND in both the 2 varieties of mango fruits. The MC in fresh fruit (74.68 - 79.14%) whereas high load of AB (4.54-5.38 log10 cfu/g) with (P>0.05) significant difference was observed in untreated fruits of the 2 varieties. Initial load of moulds were <1.31 log10 cfu/g. After 60 days of storage, the maximum load of AB & moulds were 6.56-7.52 and 5.71-6.91 log10 cfu/g, respectively. Vit-C & load of anti-nutritional contents in samples were observed in their appreciable levels. All the parameters under the proximate analysis were vary due to absorption of moisture at ambient condition during the storage time Overall acceptability of treated and untreated samples reached 5.24 (like slightly) and 4.70 (neither like nor dislike) respectively after 3 months. The total load of AB (7.52 log10 cfu/g) in all untreated samples was the reason that why samples were not allowed for panelists for taste. This was due to the point of sensory rejection in which the number of microbial load should be below the 10^7-10^8 log10 cfu/g (EU 1995). In general, as the storage time of dried fruits increase, there was: an increase of microbial population and reduction in acceptability of the products through the storage time.

V. Conclusion

The findings reveal that the two varieties of mango fruits contain appreciable amounts of nutrients that the body requires for its normal metabolic functions. The hot spices should be applied for preservation purpose to inactivate microbial load and lengthen shelf-life of fruits. The anti-nutrient contents are negligible by international standard. The local mango fruit variety is most recommended for human consumption because of its organic originate and less its susptiblity in contents by microbial contamination.

VI. Recommendations

Based on findings of this study, the following recommendations are made in order to improve the quality of dried fruits: Improved mango fruit handling, processing and preservation must be promoted. Additionally, intensive research and technology transfer of optimizing pre-treatment prior to drying and drying

technologies in mango fruit processing and preservation should be encouraged. Any more anti-nutrients associated with mango fruits should be investigated. Researches also needed to investigate the effect of different types of packaging materials & storage times on microbial quality and shelf-life of dried mango fruits for its long storage. More in depth research that will allow a longer period of storage can be explored with a view to standardizing the spices as well as establishing the exact 'Shelf life' of the product.

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