Evaluation of the mineral and sensory properties of fresh and dried honeydew fruits (cucumis melo var. Inodorus) and juice

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ABSTRACT

Background: *Honeydew fruit is rich in vitamins and minerals essential for human growth and development. Need to provide information on the mineral constituents of both fresh and dried parts of the fruit.*

Objective: The study evaluated the mineral contents of fresh and dried honeydew fruit (Cucumis melo) and juice.

Methods: *Fresh honeydew was thoroughly washed to remove any dirt, debris, or potential contaminants from the surface. The cleaned fruit was cut in half and the endocarp, mesocarp and epicarp were separated making sure the green rind part of the fruit epicarp is left untouched. The processed fresh and sun-dried fruit were subjected to mineral analysis by standard procedures. Data obtained were subjected to analysis of variance (ANOVA) while Duncan's Multiple Range Test was used in separating the means at significance difference of 5 % level of probability.*

Result: *The mineral composition of dried epicarp, mesocarp and endocarp of honeydew fruits showed that iron, Calcium, Phosphorus and Potassium ranged from 3.29 to 7.72 mg/100g, 2.23 to 11.31 mg/100g, 13.60 to 112.50 mg/100g and 5.05 to 51.16 mg/100g, respectively while in the fresh samples, endocarp had the highest value in almost all the samples except from potassium in mesocarp. The result of the sensory attributes of fresh and dried honeydew juice showed that appearance, flavour, aroma, taste and general acceptability ranged from 7.93 to 8.47, 7.53 to 7.73, 7.07 to 7.73, 7.73 to 7.80 and 7.60 to 8.07 respectively.*

Conclusion:*The study revealed significant difference ($p<0.05$) in the mineral composition of the dried honeydew fruits with dried endocarp recording higher values for calcium (11.31 mg/100g) and phosphorus (112.50 mg/100g). Similarly, fresh endocarp revealed significant ($p<0.05$) higher values for calcium (9.74 mg/100g) and phosphorus (mg/100g). The result of the sensory analysis indicated that dried juice samples recorded higher overall acceptability. The study recommends dried and fresh endocarp honeydew fruits for an improved amount of calcium, phosphorus, iron and potassium.*

Keywords: *Honeydew fruit, mineral, epicarp, mesocarp, endocarp*

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INTRODUCTION

Honeydew fruit (*Cucumis melo var. inodorus*), is a popular and refreshing summer fruit that belongs to the Cucurbitaceae family. Known for its sweet, succulent flesh and high-water content, honeydew is important for its taste and potential health benefits(1). Honeydew fruit, known for its refreshing flavor and juicy flesh, has gained popularity as a nutritious choice among health-conscious individuals (1, 2). Honeydew fruit is a rich source of vitamins and minerals essential for human health(2). Studies have shown that honeydew fruit contains significant amounts of vitamin C, an antioxidant known for its role in maintaining immune function and protecting the body against oxidative stress(3,4). Moreover, honeydew fruit is a good source of various B vitamins, including B6, which is essential for proper brain development and function, and folate, important for DNA synthesis

and cell division (1,2). In addition to vitamins, honeydew fruit is packed with several minerals beneficial for human health(4). Potassium, an electrolyte, and a key component in maintaining fluid balance and nerve function, is found in abundance in honeydew fruit, making it a valuable part of an adequate diet (5, 6). Magnesium, another essential mineral, plays a crucial role in bone health, energy production, and muscle function, all of which contribute to overall well-being (7, 8). The presence of these minerals further showcases the nutritional value of honeydew fruit.

Honeydew fruit is known to be low in calories and fat, making it an excellent choice for those pursuing weight management or a healthy diet(6). Research suggests that incorporating low-calorie foods, such as honeydew fruit, into daily meals can contribute to satiety and overall energy balance (9,10). As part of an adequate diet, honeydew fruit can thus potentially help individuals maintain a healthy body weight. Besides its vitamin and mineral content, honeydew fruit has also demonstrated potential health benefits due to its bioactive compounds. These compounds, including carotenoids, flavonoids, and phenolic compounds, possess antioxidant properties and have been associated with reduced risk of chronic diseases such as heart disease and certain types of cancer (11,12). The presence of these bioactive compounds enhances the nutritional value of honeydew fruit and suggests its potential role in disease prevention and overall health promotion. The nutritional properties of honeydew fruit make it a valuable addition to an adequate diet. Its abundance of vitamins, minerals, low-calorie content, and presence of bioactive compounds contribute to its potential health-promoting effects.

Numerous studies have reported the significant pharmacological activities, antimicrobial activity, anticarcinogenic and genotoxic effects of honeydew. However, most of these works were limited to the whole fruits of the plant without specifically providing detailed information on the mineral constituents of both fresh and dried parts of this fruit. This finding will allow a better understanding and knowledge of the nutritional quality of the epicarp, mesocarp and endocarp of honeydew fruit.This study was therefore designed to evaluate the mineral contents ofthe epicarp, mesocarp and endocarp of fresh and dried honeydew fruit (*Cucumis melo*).

MATERIALS AND METHODS

Research Design

A completely randomized design (CRD) was adopted for this study.

Sources of Materials

Samples of fresh of honeydew fruits were purchased from Wurukum Market, Makurdi, Benue State and were immediately taken to the Department of Botany, Joseph Sarwuan Tarka University, Makurdi for proper agronomic identification. Some portions of the identified fresh samples were then sun-dried for 4 days to achieve the dried portions of the overall samples used for the study. All materials were immediately taken to the Department of Nutrition and Dietetics Joseph Sarwuan Tarka University, Makurdi for further processing.

Preparation of fresh and dried honeydew epicarp, mesocarp and endocarp for Analysis

The method of fruit drying as described by Mozumder *et al*(13) was incorporated in the preparation of honeydew epicarp, mesocarp and endocarp powders. The freshly collected honeydew fruits were thoroughly washed to remove any dirt, debris, or potential contaminants from the surface with clean water. The cleaned fruits were cut in half and the endocarp, mesocarp and epicarp were separated making sure the green rind part of the fruit epicarp is left untouched. The epicarp and the mesocarp were sliced (10mm thickness) separately and the fresh samples were immediately packed into sterilized airtight containers ready for analysis, while the samples to be dried were arranged on drying trays, the sliced honeydew epicarp, mesocarp and endocarp were sun-dried separately for 96 hours (4 days). The dried epicarp, mesocarp and endocarp were packed into separate air tight containers for mineral analysis. The flow chart for the preparation of fresh and dried honeydew powder is shown in Figure 1 and 2. respectively.

Production of Honeydew Juice

The modified method adopted by Victor-Aduloju *et al*. (14) in juice production was used for the preparation of honeydew juice. The fresh fruits of honeydew were sorted, thoroughly washed under tap water and peeled with knife and diced. The diced fruits were weighed and blended using an electric juice maker Binatone BLS-330. All juice samples were prepared without addition of water, sugar and citric acid. The flow chart for the preparation of honeydew juices is presented in Figure 3.

Plate 1: Honeydew Fruits

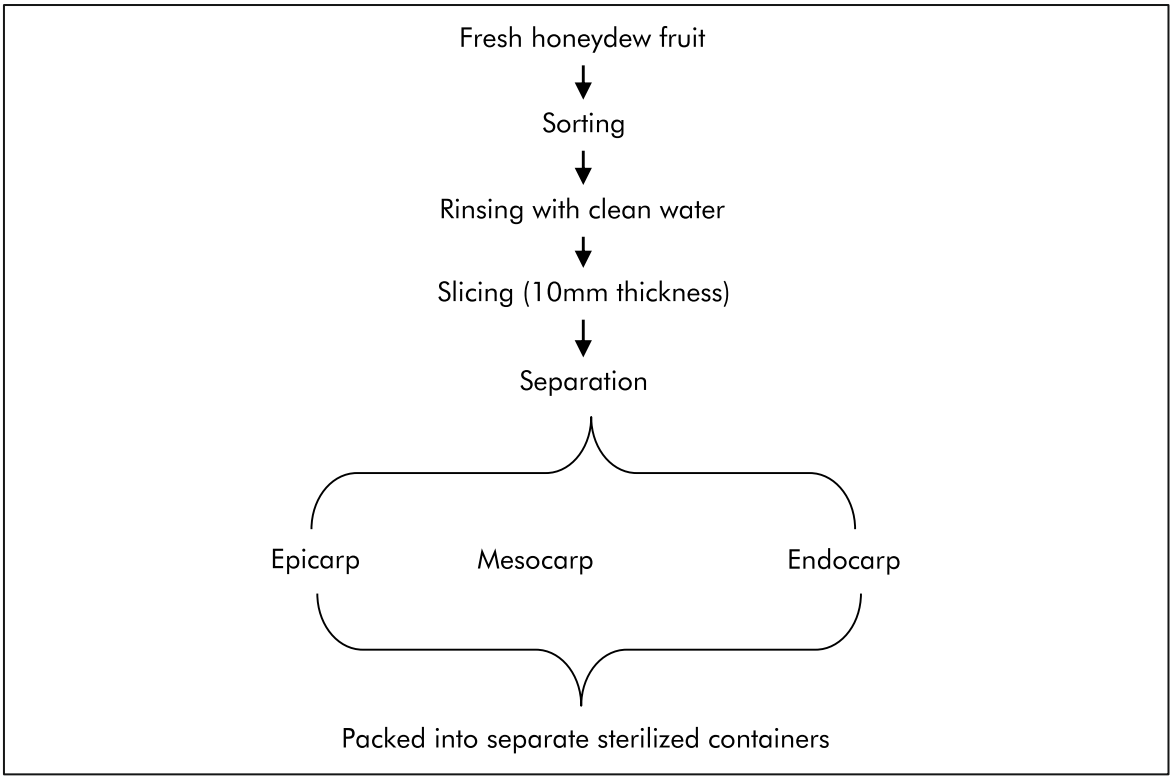

Figure 1: Flowchart for the Preparation of Fresh Honeydew Fruit samples

Source: (13)

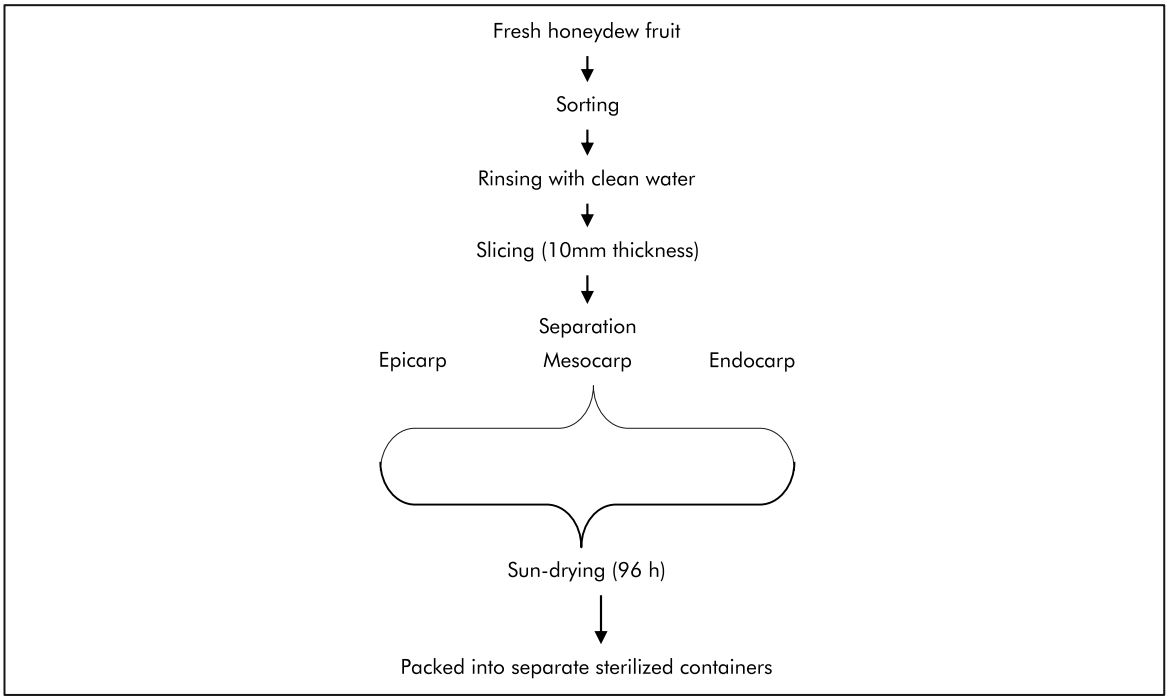

Figure 2: Flowchart for the Preparation of Dried Honeydew Fruit Samples
Source: (13)

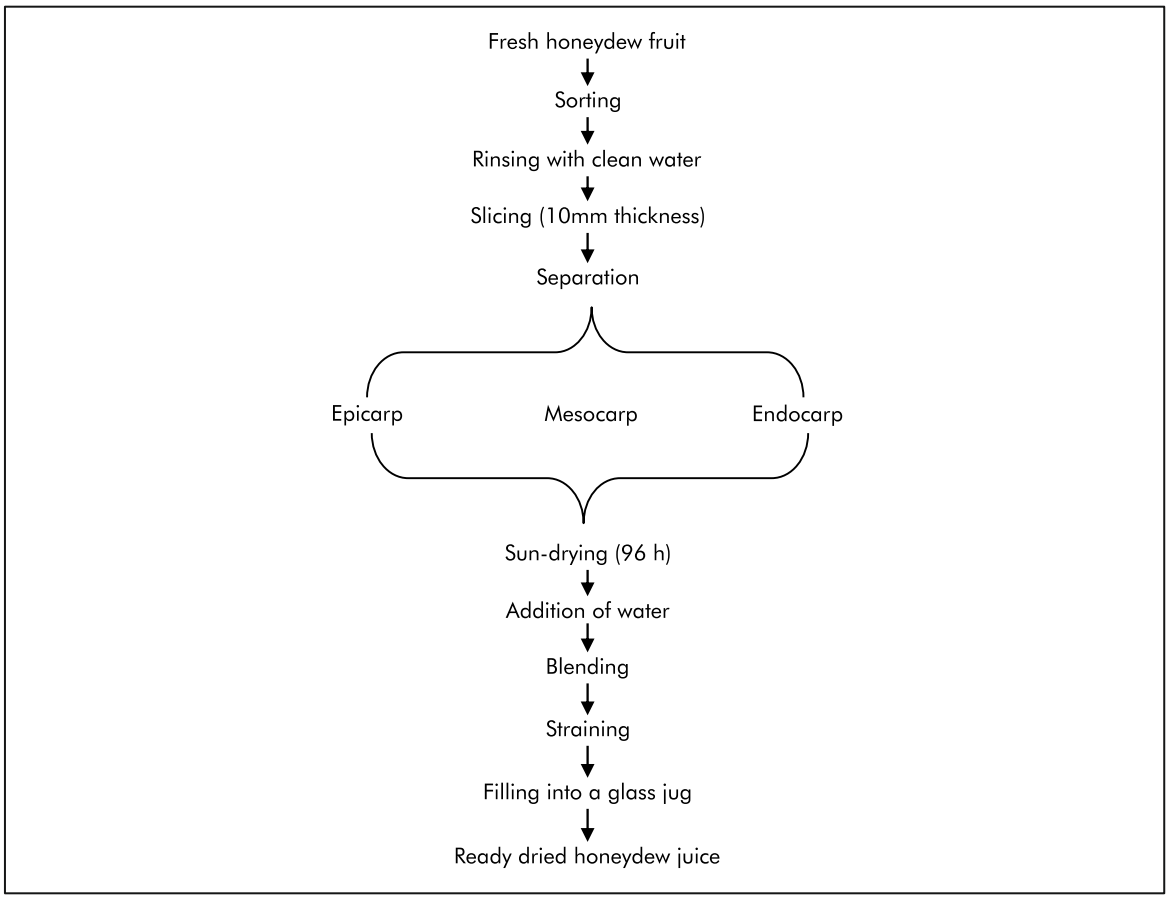

Figure 3: Flowchart of Dried Honeydew Juice production
Source: (14) Modified

Figure 4: Flowchart of Fresh Honeydew Juice production
Source: (14) Modified

CHEMICAL ANALYSIS

Determination of iron

Standard procedure proposed by AOAC (15) was used in determining the iron content of the samples. Standard solution containing 100mg/ml of Fe^{3+} ions was prepared from 1g pure iron wire. The wire was dissolved in 20ml concentrated HNO_3, boiled in water bath and diluted to 1000ml with distilled water. Standard solutions with concentrations 0,0.5, 1.0, 2.0 and 4.0ppm were prepared. Two milliliter of sample aliquot was diluted to 100ml and was used to determine the absorbance of the sample using an AGILENT (Model 5805, Agilent Spec England) atomic absorption spectrophotometer at 510nm. The standard and samples absorbance were noted and concentration of iron in the sample was determined from the standard curve.

Determination of calcium

Calcium was determined using the atomic absorption spectrophotometer recommended by AOAC (15). Calcium carbonate (2.495g) was dissolved and diluted to 100ml with de-ionized water. This solution contained 1000mg Ca^{2+} ions and from this stock solution, calcium standard of the following concentration levels 0.0, 3.0, 6.0, 9.0 were prepared. The absorbance of both the sample and the standard working aliquot were determined in the AGILENT (Model 5805, Agilent Spec England) atomic absorption spectrophotometer at 239.9nm.
The concentration of the test mineral in the sample was calculated with reference to the graph (standard curve) and obtained as follows:

$$Ca\ (mg/100g) = \frac{100 \times X \times Vf \times D}{W \times 100 \times Va}$$

W = Weight of the sample analyzed
X = Concentration of Ca obtained from the standard curve
Vf = Total volume of extract;
Va = Volume of extract used; D = Dilution factor

Determination of Phosphorus

The phosphorus content of the samples was analyzed according to AOAC (15). This was determined after drying and ashing in a muffle furnace for several hours until white-grey ash was obtained. When cool, 20ml of distilled water and 10ml of the dilute hydrochloric acid (HCL) was added to the ashed material. This mixture was boiled, filtered into a 250ml volumetric flask, washed thoroughly with hot water, cooled and made up to volume. Samples were analyzed for phosphorus and estimated quantitatively using an atomic absorption spectrophotometer (scientific model VGP 210) using filters that match the phosphorus elements.

Determination of potassium

Potassium determination was by Flame Photometry (15). 1.0g of the sample was dissolved in 20ml of acid mixture (650ml of concentrated HNO_3; 80ml PCA; 20ml conc. H_2SO_4) and aliquots of the diluted clear digest were taken for photometry using Flame analyser.

Sensory Properties of Juices Produced from Dried and Fresh Honeydew Fruit

Sensory evaluation of the juice samples prepared

from fresh and dried honeydew fruits were carried out according to the method described by Retapol and Hooker(16). A panel of thirty (30) members consisting of students and members of staff from Nutrition and Dietetics Department, Joseph Sarwuan Tarka University, Makurdi, Nigeria was chosen based on their familiarity and experience with juices' consumption for sensory evaluation. Juices produced from three parts of the fruit were presented in coded form and was randomly presented to the panelists. The panelists were provided with portable water to rinse their mouth between evaluations. However, a questionnaire describing the quality attributes (appearance, taste, flavour, aroma, mouthfeel and overall acceptability) of the juice samples was given to each panelist. Each sensory attribute was rated on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely).

STATISTICAL ANALYSIS

The data generated were subjected to analysis of variance (ANOVA) using SPSS version 26 and means were separated using Duncans Multiple Range Test while significance difference was tested at 5 % level of probability.

RESULTS

Mineral Composition (mg/100g) of Dried Honeydew Fruit

Presented in Table 1 is the mineral composition of dried epicarp, mesocarp and endocarp of honeydew fruits. Generally, the differences in the results of the mineral parameters of all the three parts were significant ($P<0.05$) except for calcium where no significant ($P>0.05$) difference was observed across the three samples. The iron (Fe) ranged from 3.29 to 7.72 mg/100g. The highest value for iron was obtained from dried mesocarp (7.72 mg/100g), followed by dried endocarp (5.85 mg/100g) and the least value was from dried epicarp (3.29 mg/100g). Calcium (Ca) ranged from 2.23 to 11.31 mg/100g. The highest calcium content was obtained from dried endocarp (11.31 mg/100g), followed by dried epicarp (7.27 mg/100g) and the least value was recorded for dried mesocarp (2.23 mg/100g). Phosphorus (P) ranged from 13.60 to 112.50 mg/100g. The highest value was obtained from dried endocarp (112.50 mg/100g) and was followed by dried mesocarp (32.57 mg/100g), while the least phosphorus value was from dried epicarp. The Potassium (K) ranged from 5.05 to 51.16 mg/100g. The highest value of potassium was obtained from dried mesocarp (51.16 mg/100g), while the least values were obtained from dried epicarp (6.33 mg/100g) and dried endocarp (5.05 mg/100g) respectively.

Mineral Composition (mg/100g) of Fresh Honeydew Fruit

Table 2 presents the mineral composition of fresh honeydew fruit. Generally, the differences in the mineral content of the fresh honeydew fruit were significant ($P<0.05$). Iron ranged from 1.82 (fresh epicarp)-5.69 mg/100g (fresh endocarp). The highest iron content was obtained from fresh endocarp (5.69 mg/100g), followed by fresh mesocarp (2.20 mg/100g). Calcium ranged from 0.17 (fresh mesocarp) to 9.74 mg/100g (fresh endocarp). The highest value was obtained from fresh endocarp (9.74 mg/100g), followed by fresh epicarp (4.10 mg/100g), while the least was obtained from fresh mesocarp (0.17 mg/100g). The phosphorus content ranged from 3.14 (fresh epicarp) to 102.79 mg/100g (fresh endocarp). Fresh endocarp had the highest value of 102.79 mg/100g and was followed by fresh mesocarp (6.24 mg/100g). The least phosphorus value was obtained in fresh epicarp (3.14 mg/100g). Potassium ranged from 2.22 (fresh epicarp) to 112.64 mg/100g (fresh mesocarp). Fresh mesocarp recorded the highest value for potassium (112.64 mg/100g) and was followed by fresh endocarp (4.28 mg/100g) while the least potassium value was obtained from fresh epicarp (2.22 mg/100g).

Sensory Properties of Juice Produced from Dried and Fresh Honeydew Fruits

The sensory properties of juice produced from dried and fresh honeydew fruit is presented in table 3. Generally, the dried honey juice had the highest values except in appearance which the fresh sample was higher. The appearance was 7.93 (fresh juice) and 8.47 in (dried juice), flavour7.73 (dried juice) and 7.53 (fresh juice). The aroma of the juices ranged between 7.07 and 7. 37from fresh and dried juices respectively. The taste of the juices was7. 37 and 7.80 from fresh and dried juice. The general acceptability of the juices showed that dried juice was highly accepted (8.07) than the fresh honeydew juice (7.60).

DISCUSSION

The mineral contents of the samples reported in this study for both fresh and dried honeydew are however lower than that reported for iron, calcium and phosphorus by Mallek-Ayadeit al (17). The observed differences may be due to the fact that the authors analyzed for the whole part of *Cucumis melo*

Table 1: Mineral Composition (mg/100g) of Dried Honeydew Fruit

Samples	Iron	Calcium	Phosphorus	Potassium
Dried epicarp	$3.29^{c}\pm0.06$	$7.27^{a}\pm10.28$	$13.60^{c}\pm0.06$	$6.33^{b}\pm0.00$
Dried mesocarp	$7.72^{a}\pm0.41$	$2.23^{a}\pm0.00$	$32.57^{b}\pm0.01$	$51.16^{a}\pm0.25$
Dried endocarp	$5.85^{b}\pm0.11$	$11.31^{a}\pm0.15$	$112.50^{a}\pm0.18$	$5.05^{c}\pm0.00$

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts are significantly ($p<0.05$) different

Table 2: Mineral Composition of Fresh Honeydew Fruit

Samples	Iron	Calcium	Phosphorus	Potassium
Fresh epicarp	$1.82^{c}\pm0.08$	$4.10^{b}\pm0.18$	$3.14^{c}\pm0.35$	$2.22^{c}\pm0.04$
Fresh mesocarp	$2.20^{b}\pm0.04$	$0.17^{c}\pm0.00$	$6.24^{b}\pm0.00$	$12.64^{a}\pm0.00$
Fresh endocarp	$5.69^{a}\pm0.07$	$9.74^{a}\pm0.11$	$102.79^{a}\pm0.36$	$4.28^{b}\pm0.00$

Values are means ± standard deviations of triplicate determinations. Means in the same column with different superscripts are significantly ($p<0.05$) different

Table 3: Sensory Properties of Juice Produced from Dried and Fresh Honeydew Fruits

SAMPLE	Fresh Juice	Dried Juice	P-value
Appearance	7.93±0.88	8.47±0.83	0.59
Flavour	7.53±0.74	7.73±0.70	0.20
Aroma	7.07±0.88	7.73±0.70	0.22
Taste	7.73±1.10	7.80±0.86	0.02
General acceptability	7.60±0.83	8.07±059	0.03

Values are means ± standard deviations of duplicate determinations. Means in same row with p-value less than 0.05 are significantly different

L. fruits, whereas, the present study analyzed selective parts (epicarp, mesocarp and endocarp) of honeydew fruits.

Minerals are inorganic elements which are essential for the normal functioning of the body. They are required in smaller quantities in addition to proteins, carbohydrates, fats and vitamins, they are inorganic or "ash constituents" of foods which cannot be destroyed by heating (18). Although they yield no energy, they have important roles to play in many activities in the body (19). As ash content gives an insight to the mineral content of the food, hence, food produced from dried epicarp, mesocarp and dried endocarp can be described as a rich source of minerals as seen from the significant ($P<0.05$) higher mineral contents of honeydew. The dried honeydew fruit samples appeared to be good source of iron, calcium, phosphorus and potassium. In both dried and fresh honeydew fruit, the endocarp exhibits the highest iron content. Specifically, the iron content in the dried endocarp is 5.85 mg, compared to 5.69 mg in the fresh endocarp. However, drying significantly increases the iron content in the epicarp and mesocarp. For instance, the dried mesocarp contains 7.72 mg of iron, while the fresh mesocarp has only 2.20 mg. This increase is consistent with findings from Norton *et al,* Khan *et al,* and Mohammed *et al*(20; 21; 22), which indicate that the drying process elevates iron concentration by

removing water content and concentrating the remaining nutrients. Calcium content is highest in the endocarp for both dried and fresh samples, with 11.31 mg in the dried endocarp and 9.74 mg in the fresh endocarp. Drying generally increases the calcium content in the epicarp and mesocarp, though the increase is more substantial in the endocarp. Similar trends have been observed in studies by Mishra et al. (23) and Sun et al. (24) on dried fruits, where the calcium levels increase post-drying due to water loss and nutrient concentration. Phosphorus is predominantly found in the endocarp, with the dried endocarp containing 112.50 mg and the fresh endocarp 102.79 mg. Drying significantly increases phosphorus content across all parts of the fruit. The mesocarp shows a particularly large increase from 6.24 mg in fresh to 32.57 mg in dried. This aligns with findings of Kovalenko (25) on grapes, where phosphorus concentration increases after drying due to the dehydration process.

The potassium content is notably highest in the dried mesocarp, which has 51.16 mg compared to 12.64 mg in its fresh counterpart. Similarly, drying tends to increase the potassium content in all parts of the honeydew fruit, with the mesocarp showing the most significant rise. This pattern is consistent with research on dried tomatoes and potatoes, which also report substantial increases in potassium levels post-drying Bhatkar et al. (26). The observed increases in mineral concentrations upon drying are consistent with broader findings in the literature. For example, studies on dried apples and bananas show similar increases in calcium levels, while dried tomatoes and potatoes exhibit significant rises in potassium content Mishra et al. (23). The concentration effect due to water removal during drying processes is a common phenomenon across various fruits and vegetables (26) .

The sensory attributes of dried and fresh honeydew fruitsshow that the juice produced from dried honey dew fruit was more acceptable than the juice from fresh fruit.The high sensory values of these foods could be due to the color, flavor, and texture of honeydew fruits which is transferred to the final products on processing. Olugbenga, et al.(27) also reported similar observations for juice produced from fresh and dried roselle calyces in which juice from dried roselle calyces recorded the best overall sensory acceptability due to the arrays of color and taste which the fruit supplies. They (27) also stated that honeydew fruits are an excellent source of vitamins and minerals and supply a range of sensory characteristics which enhances their eating attractiveness. Ghodke and Mane,(28) also reported the same trend for fresh honeydew fruits and guava jam blends in which fresh honeydew jam recorded the best overall sensory acceptability due to the arrays of color and taste of the fruits.

CONCLUSION

The study revealed significant difference ($p<0.05$) in the mineral composition of the dried honeydew fruits with dried endocarp recording higher values for calcium (11.31 mg/100g) and phosphorus (112.50 mg/100g). similarly, fresh endocarp revealed significant ($p<0.05$) higher values for calcium (9.74 mg/100g) and phosphorus (mg/100g). The result of the sensory analysis indicated that dried juice samples recorded higher overall acceptability. The study recommends dried and fresh endocarp honeydew fruits for an improved amount of calcium, phosphorus, iron and potassium.

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