Original Research Article

PHYSICO-CHEMICAL, ANTIOXIDANT PROPERTIES AND SENSORY ATTRIBUTES OF GOLDEN MELON (*Cucumis melon L*)-WATERMELON (*Citrullus lanatus*) JUICE BLENDS

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Abstract

This study investigates the physico-chemical, antioxidant properties and sensory attributes of golden melon-watermelon fruits juice blends. The juice extracted from golden melon and watermelon fruits were mixed together in different ratios 100% watermelon (GMW 1), 100% golden melon (GMW 2), 50% golden melon and 50% watermelon (GMW 3), 70% golden melon and 30% watermelon (GMW 4), 30% golden melon and 70% watermelon (GMW 5) in order to establish possible synergetic effect. The proximate composition of the samples ranged from 92.07 – 93.91%; 0.49 – 0.81%; 1.83 – 4.91%; 1.80 – 3.62% for moisture content, total ash, crude protein and carbohydrate respectively. The pH of the fruit juice blends ranged from 5.40 to 5.48. There is no significant difference ($p<0.05$) among the fruits juice samples. The mineral composition of the fruit juice for sodium (Na), potassium (K), iron (Fe), and calcium (Ca) ranged from 17.01 to 41.76 mg/100g, 9.26 to 38.51 mg/100g, 0.38 to 1.88 mg/100g, and 3.49 to 8.96 mg/100g respectively. The result shows that the total phenolic content ranged from 6.32-10.20 mg GEA/ 100g; total flavonoid ranged from 0.08-0.13 mg QAE/ 100g; DPPH ranged from 55-80%; ABTS ranged from 0.022-0.025 mmol. TEAC/ 100g and FRAP ranged from 1.20-4.23 mg AAE/g. The results of sensory attributes of the fruit juice revealed that, fruit juice GMW 5 was the most preferable in aroma, taste and overall acceptability by the panelist. Hence, golden melon-watermelon fruit juice blends may serve as a source of strong antioxidant property that may be used to improve health status.

Keyword: Physico-chemical, antioxidant, sensory attributes, golden melon and watermelon, juice blend.

Introduction

The consumption rate of fruits are increasingly gaining more popularity [1], which is due to the fact that fruits are rich sources of phenolic compounds [1-4]. They exert a variety of physiological effects such as antioxidant, antimicrobial and immunomodulatory activities [1, 5, 6]. The presence of antioxidants in fruits such as phenolic, flavonoid, carotenoids and vitamins [1, 7] play an important role in defending the body against free radicals and delay or inhibit lipid oxidation and other biomolecules, thereby preventing and repairing damage of body cells caused by the free radicals [1, 8]. Golden melon fruit (*Cucumis melon L*) popularity in Western Nigeria is limited and it is categorized as an underutilized fruits [9]. It is highly perishable, low in energy and an excellent source of micronutrients, most especially vitamin C and carotenoid, precursor of vitamin A [10]. Watermelon (*Citrullus lanatus*) are rich source of minerals such as potassium, calcium, phosphorus, magnesium, iron, and are high in vitamin C and A. They are good choice for weight control [11-13].

Processing and extraction of golden melon-watermelon fruit juice will reduce post-harvest wastage and increase the economic value of these fruits, which may be transform into finish products that can be stored and market [14]. However, there is paucity of information on the antioxidant properties of golden melon-watermelon fruit juice blends. Therefore, this study seeks to investigate the physico-chemical, antioxidant properties and sensory attributes of golden melon-watermelon fruits juice blends.

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Materials and Methods

Sources of materials

Golden melon and water melon were purchased from Fruit garden market, Ibadan, Oyo State, Nigeria. The fruits were authenticated at the Department of Crop, Soil and Pest Management, Federal University of Technology Akure, Nigeria. The chemicals used for the analysis were of analytical grade.

Processing of fruit juice

Golden melon-watermelon fruits juice blend was sorted, washed using clean water, peeled, extracted using ZFTOPA Juice Press Machine, (Model A2000, Zhoufeng Machinery and Technology Co., Ltd, Henan, China), sieved pasteurized, blend where necessarily using blending ratios stated in Table 1, packaged in a polyethylene terephthalate (PET) and stored under refrigerated condition prior to analysis [15].

Table 1: Formulation of golden melon and water melon juice blends.

Samples	Golden melon (%)	Water melon (%)
GMW 1	0	100
GMW 2	100	0
GMW 3	50	50
GMW 4	70	30
GMW 5	30	70

Chemical Analysis

Determination of proximate composition

Proximate compositions, that is, moisture, protein ($N \times 6.25$), and ash of fruit juice samples were determined using the standard methods [16]. Carbohydrate content was determined by difference.

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Determination of physico-chemical properties

The physico-chemical properties determined include: pH (using Digital Labtronics, pH meter Model LT 50, India); total titratable acid (TTA); brix level (total sugar) using hand refractometer and total soluble solid. They were all determined using standard methods as recorded by [16].

Determination of Minerals and Vitamins

Mineral Compositions: Calcium (Ca) and iron (Fe) were determined using Atomic Absorption Spectrophotometer (AAS Model SP9). Sodium (Na) and potassium (K) in the fruit juice samples were determined using flame emission photometer (Sherwood Flame Photometer 410, Sherwood Scientific Ltd. Cambridge, UK) with NaCl and KCl as the standards [16].

The total carotenoid (precursor of vitamin A), vitamin C and E were all determined using standard scientific method as recorded by [16].

Determination of antioxidant properties

Total phenolic content assay

The total phenolic content of the fruit juice was determined using Singleton *et al* [17] method.

Total flavonoid content assay

The total flavonoid content of the fruit juice was determined using a slightly modified method reported by Meda *et al* [18].

Determination of ferric reducing property

The ferric reducing property of the fruit juice was determined by assessing their ability to reduce $FeCl_3$ solution as described by Oyaizu [19].

Free radical scavenging ability assay

The free radical scavenging ability of the fruit juice against DPPH (1, 1-diphenyl–2 picrylhydrazyl) was also evaluated as described by Gyamfi *et al* [20].

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Trolox equivalent antioxidant capacity (TEAC) assay

Trolox equivalent antioxidant capacity (TEAC) of the fruit juice was determined by their 2, 2′-azino-bis (-3- ethylbenzthiazoline-6-sulphonate ($ABTS^{\bullet+}$) scavenging ability according to the method described by Re *et al* [21].

Sensory evaluation

The sensory evaluation was carried out for each sample of fruit juice by presenting freshly prepared fruit juice samples to 30 untrained panelist to rate appearance, aroma, taste and overall acceptability using 9 Hedonic scale [22].

Statistical Analysis

Data obtained from the study were analyzed using mean and Standard Error of Mean (SEM) for triplicate value. One-way Analysis of Variance (ANOVA) was performed and the means were separated by New Duncan Multiple Range Test (NDMRT) using Statistical Package for Social Science (SPSS) version 21.

Results and Discussion

Proximate composition

The proximate composition of the fruit juice samples is presented in Table 2. The proximate composition of the samples ranged from 92.07 – 93.91%; 0.49 – 0.81%; 1.83 – 4.91%; 1.80 – 3.62% for moisture content, total ash, crude protein and carbohydrate respectively.

Moisture content is defined as the quantity of water present in a particular food that is available for enzymatic reaction. The moisture content of 100% water melon fruit juice was significantly higher ($p<0.05$) than 100% golden melon. Comparatively, the high moisture content of the present findings is similar to 92% of previous studies [23, 24] for fruit juice extracted from *Curbitaceae* family respectively. The high moisture content could account for rapid deterioration

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of these fruit, if left unprocessed for long time [25] as the growth rate of microorganism increase faster in high moisture content food, hence the faster the rate of spoilage.

The protein content of 100% golden melon is significantly higher ($p<0.05$) than 100% water melon, also as the percentage of golden melon increase in the juice blend the protein content increase. This is expected because golden melon contain more protein than water melon. Even though fruit is not a rich source of protein [26]. Comparatively, the protein content of the present findings are significantly higher ($p<0.05$) than 0.72% reported by Eziaghighala *et al* [23] and this could be attributed to difference in method of fruit juice extraction, climate condition such as atmospheric temperature, relative humidity and soil water retaining capacity. It was also observed that the ash content of sample (GMW 4) was significantly higher ($p<0.05$) than other samples. This can be attributed to the fact that golden melon contains more of insoluble matter than its counterpart. High ash content of samples has been linked to high concentration of minerals [27, 28]. Hence, GMW 4 may be a better supplement for mineral deficiency. The carbohydrate contents of the developed fruit juice blends were significantly lower ($p<0.05$) than 5.43% [23]. The fruit juice samples contain no crude fibre and fat content and this is similar to the findings of Braide *et al* [29].

Table 2: Proximate compositions (%) of golden and water melon juice blends

Samples	Moisture	Total Ash	Crude Protein	Carbohydrate
GMW 1	93.91 ± 0.03^{a}	0.65 ± 0.17^{a}	1.83 ± 0.06^{e}	3.62 ± 0.25^{a}
GMW 2	92.07 ± 0.03^{e}	0.49 ± 0.00^{a}	4.32 ± 0.06^{b}	3.13 ± 0.09^{ab}
GMW 3	93.11 ± 0.08^{c}	0.65 ± 0.16^{a}	3.67 ± 0.06^{c}	2.57 ± 0.20^{b}
GMW 4	92.48 ± 0.09^{d}	0.81 ± 0.16^{a}	4.91 ± 0.06^{a}	1.80 ± 0.13^{c}
GMW 5	93.32 ± 0.03^{b}	0.64 ± 0.16^{a}	3.25 ± 0.06^{d}	2.79 ± 0.15^{b}

Mean ± SEM with the same superscript with in the same column are not significantly different ($p<0.05$).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

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Physico-chemical properties

The result of pH, brix (total sugar), total titratable acidity (TTA) and total soluble solid (TSS) of the fruit juice blends are presented in Table 3. The pH of the fruit juice blends ranged from 5.40 to 5.48. There is no significant difference ($p<0.05$) among the fruits juice samples. It was also observed that the pH concentration of the fruit juice blend was acidic which may help increase the shelf life of the juice, as microorganism reproduction rate which speed of the rate of fruit deterioration are limited in an acidic medium. The total sugar (brix) is the sugar content of an aqueous solution and it ranged from 6 to 8. The total sugar content of the fruit juice samples was found to increase significantly ($p<0.05$) with increasing volume of golden melon juice. The increase in values showed that the chemical reactions that should have consume or reduce the concentration of the sugar is at maximum e.g alcohol production. The total titratable acidity (TTA) is a measures of the ionic strength of a solution; which determine the rate of chemical reaction [30]. The TTA of the fruit juice samples ranged from 0.36 to 0.68. The fruits juice is slightly acidic in pH and lower in TTA, this indicated that the fruits were matured before harvested and processed [24]. The total soluble solid (TSS) ranged from 6.09 to 7.95. It was observed that fruit juice sample (GMW 2) had the highest content of TSS. The increase in TSS is an indication that the golden melon may have resulted in sugar-to-acid ratio in the blends and this confirmed that there is a high correlation between total soluble solid and sugar content. And these findings are similar to previous observation [31] in fruits juice production.

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Table 3: Physico-chemical properties of golden and watermelon juice blends

Samples	Ph	Brix	Total titratable acid	Total soluble solid
GMW 1	5.43±0.23[a]	6.00±0.00[e]	6.09±0.28[d]	0.68±0.23[a]
GMW 2	5.48±0.19[a]	8.00±0.00[a]	7.95±0.02[a]	0.45±0.00[a]
GMW 3	5.44±0.20[a]	6.80±0.00[c]	6.89±0.08[c]	0.41±0.03[a]
GMW 4	5.46±0.19[a]	7.00±0.00[b]	7.52±0.09[b]	0.36±0.00[a]
GMW 5	5.40±0.19[a]	6.10±0.00[d]	6.78±0.11[c]	0.42±0.03[a]

Mean ± SEM with the same superscript with in the same column are not significantly different ($p<0.05$).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

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Minerals and Vitamins

The mineral and vitamin contents of the fruit juice samples are presented on Table 4. The mineral composition of the fruit juice for sodium (Na), potassium (K), iron (Fe), and calcium (Ca) ranged from 17.01 to 41.76 mg/100g, 9.26 to 38.51 mg/100g, 0.38 to 1.88 mg/100g, and 3.49 to 8.96 mg/100g respectively. Sodium is the most abundant mineral found in the fruit juice followed by K, Ca and Fe respectively. Iron (Fe) had the lowest concentration in all the fruit juice samples. Iron is said to be an important element in the diet of pregnant women, nursing mother and infant to prevent anaemia [32]. Calcium (Ca) helps to regulate muscle contraction, transmit nerve impulse and bone formation [33]. Na/K ratio in the body is of great concern for prevention of high blood pressure. Na/K ratio for fruit juice sample (GMW 2 and GMW 3) were less than one which is recommended value for hypertensive patient [34]. Therefore consumption of this samples may be beneficial to hypertensive patient. Alongside with this, sodium and potassium are important intracellular and extracellular cations respectively, which are involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction [35].

Vitamin C, E and carotenoid (vitamin A precursor) for fruit juice samples ranged from 0.55 to 1.05 mg/100g, 0.07 to 0.54 mg/100g and 0.01 to 0.12 mg/100g respectively. The vitamin C (ascorbic acid) content in fruit juice sample GMW 1 (100% watermelon juice) is significantly higher (p<0.05) than other samples. This was expected as fruit juice has been reported to be rich sources of antioxidant must especially vitamin C [36, 37]. Vitamin C is water soluble vitamin which exhibit antioxidant properties that can serve as means for treatment of certain diseases such as catarrh [36]. It was reported that vitamin C of freshly made watermelon juice can take care of ailment like scurvy [37]. It was observed from the result that fruit juice sample GMW 4 content of vitamin E was significantly higher (p<0.05) than other fruit juice samples. Vitamin E has been linked with the ability to protect the unsaturated fatty acids in the cell membrane against oxidation of free radicals. It helps to stops this reaction by saturating peroxide and hydroperoxide with hydrogen ion, thereby reducing the activity of peroxide radicals [38]. It was also observed that the inclusion of 30% watermelon to 70% golden melon increase the quantity of vitamin E, which is attributed to the fact that water melon is a rich source of vitamin E. It was observed that carotenoid content in GMW 3 and GMW 5 fruit juice samples were significantly higher (p<0.05) than other samples, which may be as a result of the blending effects of golden and water melon fruit juice.

Table 4: Minerals and Vitamins content (mg/ 100 g) of the Fruit Juice Blends

Parameters	GMW 1	GMW 2	GMW 3	GMW 4	GMW 5
Sodium (Na)	17.01 ± 0.01^{e}	17.26 ± 0.01^{d}	21.51 ± 0.01^{c}	31.51 ± 0.01^{b}	41.76 ± 0.01^{a}
Potassium (K)	9.26 ± 0.01^{e}	38.51 ± 0.01^{a}	22.76 ± 0.01^{b}	12.75 ± 0.00^{d}	17.50 ± 0.00^{c}
Iron (Fe)	0.38 ± 0.01^{e}	1.34 ± 0.00^{c}	0.69 ± 0.00^{d}	1.88 ± 0.01^{a}	1.46 ± 0.01^{b}
Calcium (Ca)	8.96 ± 0.00^{a}	4.79 ± 0.00^{c}	4.28 ± 0.00^{d}	5.77 ± 0.01^{b}	3.49 ± 0.00^{e}
Na/K	1.83^{c}	0.45^{de}	0.94^{d}	2.46^{a}	2.39^{b}
Carotenoid	0.08 ± 0.01^{b}	0.01 ± 0.00^{d}	0.12 ± 0.01^{a}	0.03 ± 0.00^{c}	0.12 ± 0.00^{a}
Vitamin C	1.05 ± 0.09^{a}	0.77 ± 0.09^{b}	0.70 ± 0.06^{b}	0.77 ± 0.07^{b}	0.55 ± 0.05^{b}
Vitamin E	0.47 ± 0.00^{b}	0.07 ± 0.00^{e}	0.23 ± 0.01^{c}	0.54 ± 0.01^{a}	0.14 ± 0.00^{d}

Mean ± SEM with the same superscript with in the same row are not significantly different (p<0.05).

Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

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Antioxidant properties

The antioxidant activities of the fruit juice samples is shown in Figure (1a-e). The result shows that the total phenolic content ranged from 6.32-10.20 mg GEA/ 100g; total flavonoid ranged from 0.08-0.13 mg QAE/ 100g; DPPH ranged from 55-80%; ABTS ranged from 0.022-0.025 mmol. TEAC/ 100g and FRAP ranged from 1.20-4.23 mg AAE/g. The total phenolic content of GMW 4 was significantly higher ($p<0.05$) compared with other samples. The total phenolic compounds has been linked with the ability to protect the human body system from free radicals as they possess strong antioxidants abilities that are capable of scavenging free radicals, activate antioxidant enzymes, reduce alpha-tocopherol radicals and inhibit oxidases [39, 40]. Total phenolic compound are used as purgatives, to treat stomach ache and constipation. This implies that inclusion of water melon to golden melon increases the antioxidant activities and consumption of the fruit juice may be beneficial to the body system. Total flavonoids are found in trace quantity in all the samples. However, the 100% golden melon juice contains lowest quantity of flavonoids, but the inclusion of 30% watermelon juice increased the quantity of flavonoids in sample GMW 4. Flavonoids are potent water soluble antioxidants and have the ability to scavenger free radicals which prevent oxidative cell damage and have strong anticancer activity. The presence of flavonoids in the fruit juice may offer protection against inflammation, free radicals, microbes and tumor formation [33]. Therefore, consumption of blend juice (GMW 4) may be beneficial to the body.

It was observed from the present study that fruit juice blends shows a better scavenging ability against DPPH and ABTS with GMW 4 significantly higher ($p<0.05$) than other samples. This may be due to GMW 4 having the highest potential of accepting an electron to become a stable molecules against DPPH radicals and being progressively flexible as both non-polar and polar

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samples against ABTS radicals [41]. Antioxidants do their defensive job on cells in the body either by creation of free radicals or forestalling [42].

The ferric reducing antioxidant property (FRAP) result of the fruit juice blends based on their ability to reduce Fe^{3+} to Fe^{2+} [43]. Shows that sample GMW 4 was significantly higher (P<0.05) than the other samples. This shows that it has the highest ability to reduce Fe^{3+} to Fe^{2+}. The same trend is in agreement with the total phenolic, flavonoid, DPPH and ABTS free radical scavenging ability of the fruit juice samples.

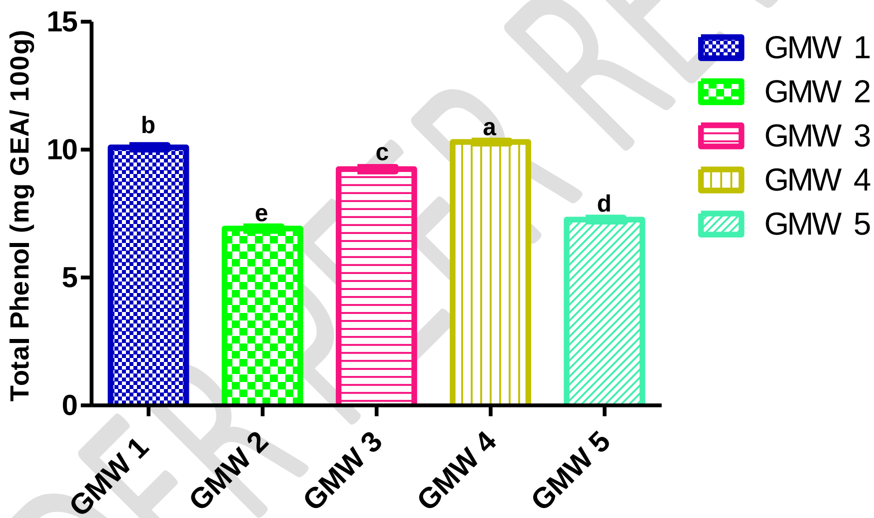

Fig. 1(a): Total Phenolic Antioxidant Activities of Golden-water Melon Fruit Juice Blend.
Mean with the same superscript are not significantly different (p<0.05).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

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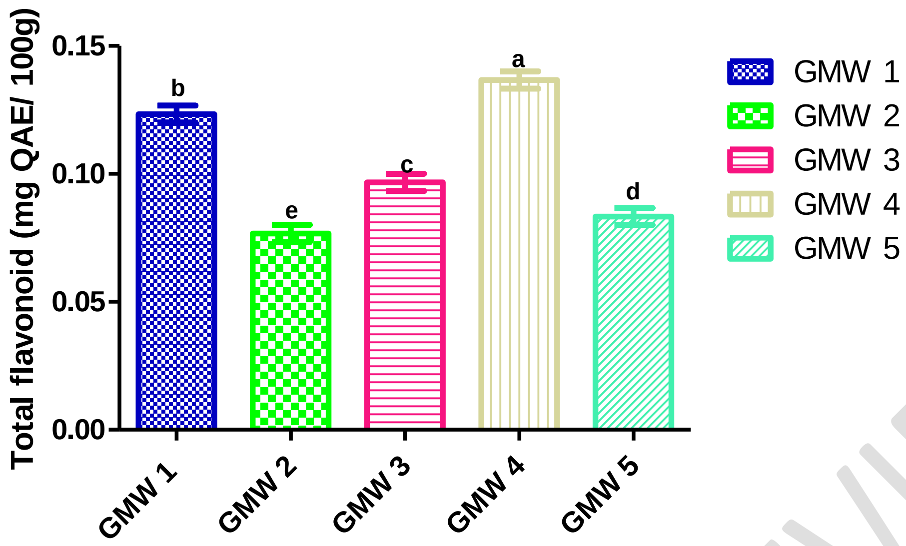

Fig. 1(b): Total Flavonoid Antioxidant Activities of Golden-water Melon Fruit Juice Blend.
Mean with the same superscript are not significantly different (p<0.05).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

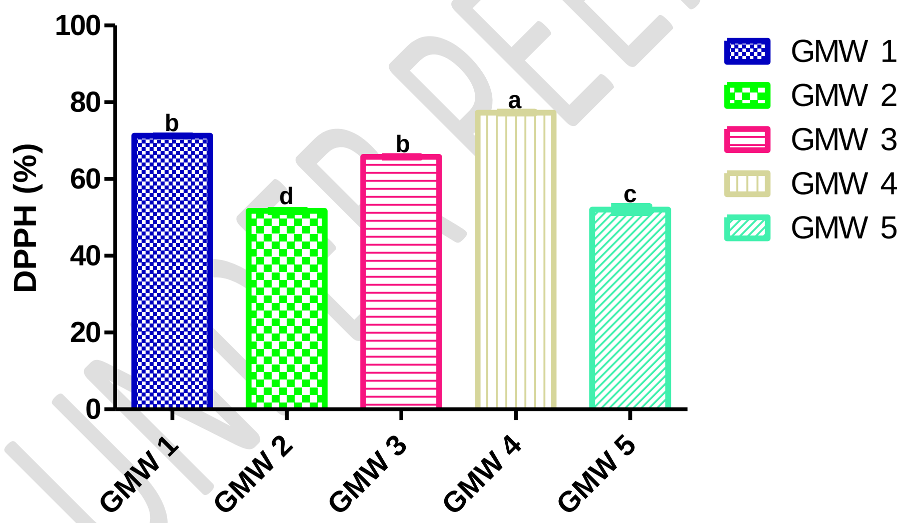

Fig. 1(c): DPPH Antioxidant Activities of Golden Melon-Watermelon Fruit Juice Blend.
Mean with the same superscript are not significantly different (p<0.05).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

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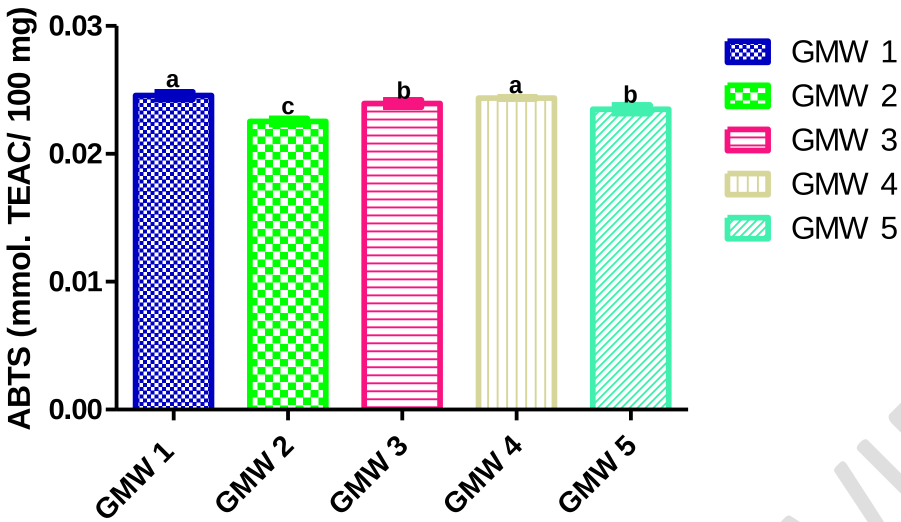

Fig. 1(d): ABTS Antioxidant Activities of Golden Melon-Watermelon Fruit Juice Blend.
Mean with the same superscript are not significantly different (p<0.05).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

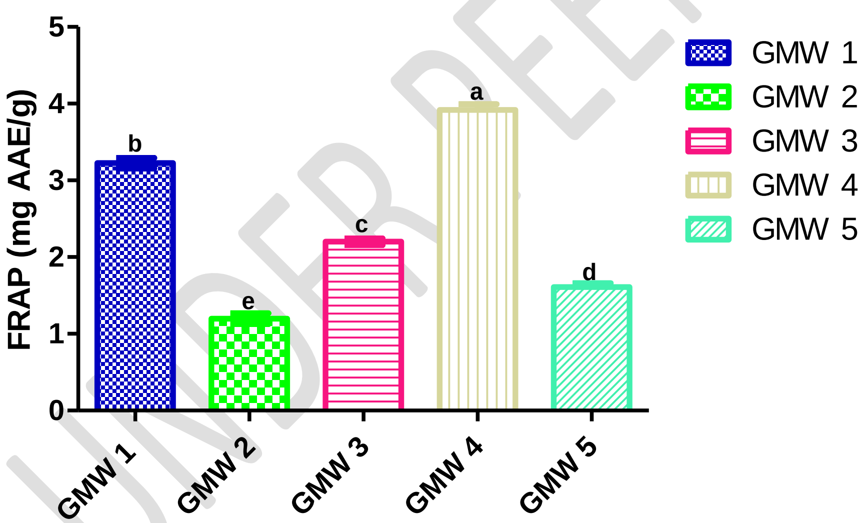

Fig. 1(e): Ferric Reducing Antioxidant Properties of Golden-water Melon Fruit Juice Blend.
Mean with the same superscript are not significantly different (p<0.05).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice

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Sensory evaluation

The results of sensory attributes of the fruit juice revealed that fruit juice GMW 5 was most preferable in aroma, taste and overall acceptability by the panelist. It may be due to the fact that it was a blend of golden and watermelon juice (ratio of 30 to 70) while GMW 1 was most preferable in appearance only. The overall acceptability of any food products is one of the important and basic criteria for the acceptance or rejection of food product [44]. However, from the results, sample GMW 5 was most preferred by the panelist and hence if processed, packaged and commercialized, it may be accepted by the large populace considering it aroma, taste and antioxidant properties.

Table 5: Sensory analysis of the golden and water melon fruit juice blends

Samples	Appearance	Aroma	Taste	Overall Acceptability	Mean
GMW 1	8.40 ± 0.21^{a}	7.60 ± 0.31^{a}	7.60 ± 0.31^{a}	7.67 ± 0.33^{ab}	7.82^{a}
GMW 2	7.93 ± 0.26^{a}	7.47 ± 0.32^{b}	7.07 ± 0.35^{b}	7.47 ± 0.32^{ab}	$7{,}48^{b}$
GMW 3	7.93 ± 0.27^{a}	7.47 ± 0.17^{b}	7.00 ± 0.38^{b}	7.47 ± 0.22^{ab}	7.47^{c}
GMW 4	7.73 ± 0.32^{a}	7.13 ± 0.29^{c}	6.87 ± 0.32^{b}	6.87 ± 0.35^{b}	7.15^{d}
GMW 5	8.00 ± 0.22^{a}	7.80 ± 0.26^{a}	7.67 ± 0.32^{a}	7.80 ± 0.24^{a}	7.82^{a}

Mean ± SEM with the same superscript with in the same column are not significantly different ($p<0.05$).
Keys: GMW 1 – 100% watermelon juice; GMW 2 – 100% Golden melon juice; GMW 3 – 50% golden melon and 50% watermelon juice; GMW 4 – 70% golden melon and 30% watermelon juice and GMW 5 – 30% golden melon and 70% watermelon juice.

Conclusion

Highest brix level and total soluble solid were obtained for 100% golden melon juice and highest vitamin C content was obtained for 100% water melon juice respectively. However, strong antioxidant activity was obtained for 70% golden melon and 30% watermelon and it was the most preferred and acceptable fruit juice by the panelist. Hence, golden melon-watermelon juice

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blends showed that, blending of fruit juices enhance their nutritional qualities, source of antioxidant property that may improve health status.

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