

PROXIMATE COMPOSITION AND SENSORY PROPERTIES OF JUICE FROM WHOLE WATERMELON AND FRACTIONS

ABSTRACT

This research work studied the juice gotten from different whole watermelon and its fractions through the assessment of proximate analysis and sensory properties of the juice samples. A Completely Randomized Design (CRD), was used in the design of the experiment. A total of 5 samples were obtained. Result of the proximate composition showed that the samples differed significantly ($p < 0.05$) and had values that ranged between 94.45 – 93.20%, 1.02 – 0.32%, 0.22 – 0.10%, 0.36 – 0.13%, 5.45 – 4.29% for moisture, ash, fat, protein and carbohydrate respectively. Sensory evaluation conducted on the juice samples showed that the samples differed significantly ($p < 0.05$) in terms of Appearance, Flavor, Aroma, Mouth feel and Overall acceptability. It was observed from the study that juice made from whole watermelon had the best acceptability. This implies that the incorporation of the different parts of watermelon will affect better nutrition to meet the demand for nutrient balance among the population.

Keywords: watermelon, proximate analysis, sensory properties.

1. INTRODUCTION

Fruit is sweet and fleshy product obtained from trees or other plant containing seeds and can be consumed as food (Oxford University Press, 2018). In food scientific term, fruits are succulent part of plant taken as appetizer or desert. Botanically, fruits develop from ovaries and form seed of reproductive organ of flowering plant which are diverse, perishable, and seasonal by nature (Asha *et al.*, 2014). Fruits contain a substantial number of antioxidants, minerals, vitamins, and dietary fiber which are vital to the human body. Thus, the consumption of fruits could help reduce the risk of many illnesses such as diabetes, cancer, cardiovascular diseases, and other illnesses (Hanzah *et al.*, 2018). According to Akusu *et al.* (2016), fruits are highly perishable non-staple foods which make up about 39% of the food intake (fresh state or processed form) of people living in developing countries. Consumption of fresh juices is increasing all over- the world due to their freshness, high vitamin content, low caloric content and ability to reduce risk of many diseases

such as diabetes, heart diseases and cancer (Rathnayaka, 2013). Furthermore, consumers are increasingly aware of the health benefits of fruits consumption. WHO (2012) stated that low consumption of fruits and vegetables is the environmental cause for 31% of ischemic heart diseases and 11% of stroke worldwide.

Fruit growth, maturation and ripening depend on fruit species or variety (Nirmal *et al.*, 2012). According to Nirmal *et al.* (2012), and Jimenez-Sanchez *et al.* (2015), fruits contain vitamins such as vitamins A, C, E and K, minerals such as Na, Ca, K, Mg, fibers, phytochemicals, organic acid and other nutrients that are essential to humans. Fresh fruits have typically between 75 and 95 percent water which accounts for the juicy refreshing distinguishing feature of fruits. Most fruits are more acidic than the others and the most common acids associated with fruits include citric acid, malic acid, and tartaric acid. Fruits are equally high in carbohydrates depending on the type of fruit and its maturity (Singh and McLellan, 2018). Research indicates that fruits are natural source of antioxidants, playing initiative-taking roles against chronic degeneration and aging and protects against any form of deterioration that may occur in the human body (Costescu *et al.*, 2006; Pereira-Netto, 2018). In fact, fruits constitute an inexhaustible source of nutrients, the secondary metabolites of which are among the most important (Grigoras, 2012). The quantity and type of antioxidant determines the bioavailability of the antioxidants. Tropical fruits such as guava, orange, watermelon, etc. are higher in antioxidants in comparison with some other fruits grown in temperate regions, can be of benefit in enriching the human diet (Pereira-Netto, 2018).

Taking cognizance of the perishability of fruits and their seasonal nature, the need to devise affordable and adoptable ways to process these fruits into shelf stable and acceptable products such as juices, jams, and jellies, which can now be utilized when the fruits are out of season. Alternatively, processing fruits help to minimize the post-harvest losses and save cost (Ukeyima *et al.*, 2017). Value addition to fresh fruit products remain one of the aims amongst others of fruit processing which can be achieved by application of any of these methods of processing such as drying, freezing, canning, etc. and new product creation (Sharma *et al.*, 2016).

Nutritional composition, quality characteristics, microbiological and acceptability of various fruits and fruit juices (such as watermelon, pineapple, orange), have been reported (Ogunbanwo *et al.*, 2013; Naz *et al.*, 2014; Ijah *et al.*, 2015; Ohwesiri *et al.*, 2016; Okwori *et al.*, 2017). The intake of fruits is highly recommended due to the known fact that fruits provide essential vitamins and minerals and other nutrients which are fundamental to human health. Example is the reduction of

some cardiovascular diseases and reduction of excess calorie intake. The consumption of fruit juices could have both positive and negative effects on the part of consumers.

Codex Alimentarius Commission defined fruit juice as the unfermented but fermentable liquid obtained from the edible part of sound, appropriately matured and fresh fruit maintained in sound condition. Post-harvest surface treatment and fruit juice can be obtained by mechanical expression processes, reconstitution of concentrated fruit juice with potable water and diffusion with water of pulpy whole fruit or dehydrated whole fruit (FAO, 2005). Fruit Juices are aqueous liquids expressed or otherwise extracted usually from one or more fruits (Bello *et al.*, 2014). Within fruit juice category, the regulated products (fruit juice, etc.) have been defined based on their composition, production, and processing methods. The fruit juice may be produced from a single fruit or a combination of fruits (FAO, 2005). An instance can be seen from the extraction of watermelon juice or combination of watermelon and pineapple to extract their juices. In most parts of the world, fruit juice contains 100 percent fruit. A blend of fruit juices with other ingredients, for example water, is regarded as a fruit drink. Fruit drinks are obtained by adding water to specific quantity of fruit juice. Recently, several fruits have become essential raw materials in the production of fruit juices and high moisture content of some of these fruits have prompted many researchers to use them in fruit processing (Nirmal *et al.*, 2012; Singh and McLellan, 2018). Fruit juices processed under hygienic conditions could play a significant role in enhancing consumer's health through inhibition of breast cancer, congestive heart failure (CHF) and urinary tract infection (Bello *et al.*, 2014). However, freshly extracted juices may not always be safe owing to the heavy load of microbes. The consumption of fruit juice as supplements of the main fruit has been proved to have health benefits to the consumer and processing these fruits helps to reduce post-harvest losses and equally enhance their utilization (Heyman *et al.*, 2017). The American Academy of Pediatrics (AAP) recommends that fruit juices are of no nutritional benefits to infants malnutrition have been associated with excessive consumption. It is important to note that fruit juices are not used to replace water in the treatment of dehydration (Heyman *et al.*, 2017). Juices are prepared mechanically by squeezing or macerating the pulp of fresh fruits or vegetables without application of heat or solvent to give an unfermented, clouded, unclarified and untreated juice ready for consumption. Diluting or blending is a frequent practice as many fresh juices are either too acidic or too strongly flavoured to be pleasant for consumption (Asha *et al.*, 2014).

Major ingredients of fruit juices such as water, sugar, natural fruit pulp, etc. may also carry some microbial contaminants which may cause spoilage of the drinks or gastrointestinal disorders to consumers (Asha *et al.*, 2014). The food market has stimulated the development of new products that present good sensory acceptance and of high nutritional value. Contaminants from raw materials and equipment's, additional processing conditions, improper handling, prevalence of unhygienic conditions, contributes to the entry of microbial pathogens in juices prepared from fruits (Ameh *et al.*, 2015). Processing the fruits to juice could therefore be the solution to the spoilage of fruits.

Watermelon juice, as a beverage, is found exclusively as an over- the- counter drink made by hand. Watermelon juices are rare, with commercially available packaged watermelon juice drinks still in developing countries (Alam *et al.*, 2013).

2. MATERIALS AND METHODS

2.1 Materials and Sample Collection

The material required for the preparation was fully matured, ripe and fresh watermelon fruit which was procured from Eke Awka Market in Awka South Local Government Area of Anambra State, Nigeria.

2.2 Research Design

The research design that was used in this study is a completely randomized design (CRD). (please explain the total number of samples and types of samples, and the percentage of mixture). JWW contained all parts of fruits, right? Peel, rind, and pulp.

Sample Preparation

Whole watermelon fruits were cleaned of extraneous materials. Quality check of the watermelon fruits was conducted. The quality parameters of colour, ripeness, maturity, and wholeness were checked before the fruits were selected. The selected fruits were washed first under running tap water. Then, they were washed with 5% hypochlorite solution to get rid of microbes and contaminants and then rinsed again immediately under running tap water. The whole fruits were cut longitudinally using a sterile knife, carefully fractionated and the various parts cut into small

pieces. The different fractions were separately transferred into sterile blender and homogenized until sufficient juice was produced. The entire slurry was transferred into a sterile muslin cloth to filter off the unwanted particles. The juices were pasteurized using a low temperature long time (LTLT) at 60°C held for 10 min as reported by Ohwesiri *et al.* (2016) and Okwori *et al.* (2017). The juice was aseptically transferred into clean sterile airtight bottles. The samples were cooled and evaluated for proximate and sensory properties.

2.3 Proximate Analysis of the juices

The moisture content, crude protein, ash content and fat content of the juices was determined in triplicate using established analytical procedures of AOAC (2010) except for crude protein which was determined as described by Northrop (2011). The carbohydrate content was estimated by difference from 100% after accounting for moisture, protein, ash and fat.

2.4 Sensory Evaluation of the juices

As reported by Iwe (2010), the organoleptic analysis was carried out using twenty-five member panellists consisting of students in the department of food science and technology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria who are familiar and regular consumers of watermelon fruit and juice was used. The sensory qualities that were evaluated include appearance, aroma, flavour, mouth feel and overall acceptability. The juice samples were served with clean, transparent plastic cups to each panellist. The order of presentation of the samples to the panels was randomized, potable water was also provided to rinse the mouth between evaluations. This was done using an evaluation sheet in form of questionnaire which was given to each panellist. The evaluation was conducted in an open space for easy clarification. Each sensory attribute was evaluated on a 9-point Hedonic Scale with 1 = disliked extremely, 2= dislike very much, 3= dislike moderately, 4= dislike slightly, 5=neither liked nor disliked, 6= like slightly, 7= like moderately, 8= like very much while 9 = liked extremely.

2.5 Statistical Analysis

Proximate composition and sensory evaluation data were analysed using the Statistical Package for Social Sciences (SPSS) version 23. Analysis of variance (ANOVA) was done to detect significant differences ($p < 0.05$) among the sample means. This was followed by the application of Duncan Multiple Range Test (DMRT) for the separation of the significant means.

Table 1. Treatment codes for five watermelon juice samples

Sample codes	Explanation of sample codes
JWW	Juice made from whole watermelon
JP	Juice made from the pulp
JPR	Juice made from the pulp and rind
JPP	Juice made from the pulp and peel
JR	Juice made from the rind

3. RESULTS AND DISCUSSION

3.1 Proximate composition of juice from whole watermelon and its fractions

The proximate composition of whole watermelon juice and the juices of its component fractions is shown in Table 2. The moisture content ranged from 93.20% in pulp-peel juice (JPP) to 94.45% in whole watermelon (JWW) and watermelon rind juices (JR). Following the moisture in descending order were the carbohydrate (4.29- 5.45%), ash (0.32- 1.02%), protein (0.13-0.36%) and fat (0.10- 0.22%) contents.

The moisture content of the pulp juice (JP) (93.78%) and pulp-peel juice (JPP) (93.20%) which did not differ significantly ($p < 0.05$) were significantly lower than those of the pulp-rind (JPR) (94.30%) and whole watermelon (JWW) (94.45%) juices. The low moisture content of the pulp-peel juice (JPP) maybe attributed to much lower moisture content of the peel as attempt to produce peel juice without adding water was impossible. Close observations showed that all juices with rind fractions/ components namely whole watermelon (94.45%), pulp-rind (94.30%), and rind (94.45%) had relatively higher moisture content indicating the contribution of the rind to the moisture content of the juices. Olayinka and Etejere (2018) reported that pulp and rind contained higher moisture (93.65 and 96.76%, respectively) of whole watermelon. Thus, however, contrasted the higher moisture content of rind observed in this work. According to Lixandry (2021), the white part of watermelon (rind) along with the sweet flesh (the pulp) have both over 90% water that helps consumers keep hydrated with benefits of dehydration-related tiredness, fatigue, dizziness, lethargy and headaches. Abu-Hiamed (2017) reported that moisture is the predominant component of watermelon, and it ranges from 67.00 to 87.14%. Ugbogu and Ogodu (2015) observed the moisture content of 92.93% for watermelon juice obtained from a local market in Nigeria. A range of 92.80% to 94.00% moisture was reported by Abdulazeez *et al.* (2020) for watermelon fruits

from different farms in Lapai, Niger state of Nigeria. The result is in close range (75-95 %) moisture content for fruit juices as reported by Singh and McLellan (2018). Eke-Ejiofor *et al.* (2016) recorded moisture range of 92.82 to 95.85 % which is in close relationship with all the samples. It can be deduced from the table that watermelon contains high moisture.

The ash content of watermelon fruit juices as presented in Table 2 reveals that the whole watermelon (JWW) and pulp-peel (JPP) juices had significantly ($p < 0.05$) higher ash content of 1.02% and 1.00% respectively than the test of the juices that had 0.32-0.33% ash. It is likely that the ash is mostly found in the peel which may be the reason only watermelon components/ fractions with peels had higher ash. Ugbogu and Ogbodo (2015) reported ash content of 0.94% for watermelon juice which is comparable to 1.02% ash for whole watermelon juice in this research. Olayinka and Etejere (2018) reported the ash content of 0.23% and 0.31% respectively, for the rind and pulp fractions of watermelon. This is comparable to 0.32-0.33% obtained for watermelon components/ fractions juices in this work. A range of 0.20% to 0.30% ash was observed in the rind of watermelon from different farms in Lapai, Niger State of Nigeria Abdulazeez *et al.* (2020). Al-Sayed and Ahmed (2013) reported the ash content of watermelon rind of 13.90% (dry weight basis).

Table 2 showed that the fat content of the juice ranged from 0.10% to 0.22%. Only the juice with peel component/fraction (pulp-peel juice, JPP) had significantly ($p < 0.05$) the highest value above other juice samples. This shows the low level of fat in whole watermelon juice (JWW). The fat content was the lowest compared to other proximate parameters just as observed by Abu-Hiamed (2017) who reported a range of 0.64 – 1.09% (dry weight basis) for watermelon rind and pulp. Olayinka and Etejere (2018) reported the fat content of 0.13% in the rind and 0.21% in the pulp of watermelon which are comparable to the values in Table 2 Ugbogu and Ogbodo (2015) observed a lipid value of 0.48% for watermelon juice from a local market in Nigeria while Abdulazeez *et al.* (2020) reported a range of 0.10 to 0.15% lipid for the rind of watermelon from different farms in Lapai, Niger state, Nigeria.

The protein content of the juice ranged from 0.13% in whole watermelon juice (JWW) to 0.36% in pulp-rind juice (JPR) (Table 2). Pulp (JP), pulp-rind (JPR) and pulp-peel (JPP) juices with higher protein content (0.33-0.36%) differed significantly ($p < 0.05$) from whole watermelon (JWW) and rind juices (JR) (0.13% and 0.26% respectively) which in themselves also significantly differed

($p < 0.05$). Olayinka and Etejere (2018), reporting the protein content of 0.53% for the pulp and 0.34% for the rind, noted that the protein was found out to be in high amount in the pulp when compared to the rind. The protein content of the watermelon juices (Table 2) was lower than the range of 0.55% to 0.80% reported for the rind of watermelon (Abdulazeez *et al.*, 2020) and 1.22% for watermelon fruit juice from Nigerian local market (Ugbogo and Ogodo, 2015). A protein content of 11.17% (dry weight basis) was reported for watermelon rind by Al- Sayed and Ahmed (2013).

The carbohydrate content, shown in Table 2, ranged from 4.92% in the whole watermelon juice (JWW) to 5.45% in the pulp juice (JP) (Table 2), indicating higher carbohydrate content in the pulp than any other watermelon components/fraction. The rind juice (JR) had lower carbohydrate content (4.85%) and its combination with the pulp (JPR) increased the carbohydrate content to 4.90%. The higher the carbohydrate content in the pulp-peel juice (JPP) (5.25%) than the pulp-rind juice (JPR) (4.90%) may be indicating a higher carbohydrate content of the peel component in the pulp-peel juice (JPP). A carbohydrate content of 5.22% to 5.86% was reported for the rind by Abdulazeez *et al.* (2020) while Olayinka and Etejere (2018) observed 5.22% for the rind and 4.23% for the pulp of watermelon. The later contrasted higher carbohydrate content of the pulp juice observed in this work. Carbohydrate content of 4.89% was observed by Ugbogu and Ogodo (2015) for watermelon juice from Nigeria local market while a range of 62.00- 87.14% (dry weight basis) was reported by Abu-Hiamed (2017) who noted that approximately 82% of the carbohydrate in the flesh pulp of mature watermelon fruit are sugars namely fructose, glucose and sucrose.

Crude fibre was not detected in the watermelon juice. This was because of proper crushing of the fruits. This is in line with the report of Braide *et al.* (2012).

Table 2: Proximate composition of juice from watermelon samples

Sample code	Juice source	Moisture	Ash	Fat	Protein	CHO
-------------	--------------	----------	-----	-----	---------	-----

JWW	Whole fruit	94.45 ^a ±0.05	1.02 ^a ±0.02	0.11 ^b ±0.01	0.13 ^c ±0.03	4.29 ^d ±0.01
JP	Pulp	93.78 ^c ±0.07	0.33 ^b ±0.02	0.10 ^b ±0.01	0.34 ^a ±0.01	5.45 ^a ±0.02
JPR	Pulp/Rind	94.30 ^b ±0.10	0.32 ^b ±0.02	0.12 ^b ±0.01	0.36 ^a ±0.04	4.90 ^c ±0.01
JPP	Pulp/Peel	93.20 ^c ±0.10	1.00 ^a ±0.00	0.22 ^a ±0.02	0.33 ^a ±0.03	5.25 ^b ±0.02
JR	Rind	94.45 ^a ±0.05	0.32 ^b ±0.02	0.12 ^b ±0.02	0.26 ^b ±0.03	4.85 ^c ±0.01

Values are mean scores ± standard deviation of triplicate determinations. Values bearing different superscript differ significantly ($p < 0.05$). CHO= Carbohydrate.

3.2 Sensory Properties of whole watermelon juice and its fractions

The results of the sensory evaluation conducted on the samples are presented as mean ± standard deviation in Table 3. The sensory properties evaluated were appearance, flavour, aroma, mouth feel and overall acceptability.

The average scores on appearance ranged from 6.15 (moderately liked) for a rind juice (JR) to 8.57 (extremely liked) for the pulp juice (JP). This is not surprising giving the bright red colour of the watermelon pulp. This showed that the juices were positively liked regarding appearance, the most liked or preferred juice being the pulp juice (JP) (8.57) and the least liked was rind juice (JR) (6.15). Both whole watermelon juice (JWW) (7.92) and pulp-peel juice (JPP) (7.96) were very much liked.

The preference of flavour ranged from 4.57 designated as neither liked nor disliked for the rind juice (JR) to 8.42 (very much liked) for the whole watermelon juice (JWW). The juice from pulp (JP) alone was much liked (7.46). Its combination with the rind (pulp-rind juice) (JPR) decreased the preference to moderately liked whereas the introduction of the peel to the pulp in pulp-peel juice (JPP) improved the preferences to very much liked (8.03). Hence, rind negatively impacted the preference of the pulp juice while the peel positively influenced it. Whole watermelon juice (JWW) with all the fruit fractions gave the most preferred flavour.

The aroma of the pulp with peel fraction (pulp-peel juice, JPP) was best preferred with average score of 7.50 (very much liked). Again, the rind juice (JR) with average score of 4.65 (neither liked

nor disliked) was least preferred. The aroma of pulp juice (JP) and whole watermelon juice (JWW) (6.76 and 7.29, respectively) were much liked although the later was rated higher. The pulp-rind juice (JPR) was moderately liked (5.88) indicating the negative effect of the rind on the aroma of the pulp.

Mouth feel is about the texture. The whole watermelon juice (JWW) and pulp-peel juice (JPP) were equally rated (8.26) and most preferred. They were very much liked; and followed by the pulp juice (JP) (7.46) which was much liked; and then the pulp-rind juice (JPR) that was moderately liked (6.19).

In overall acceptability, whole watermelon juice (JWW) was rated best with average score of 8.75 (extremely liked). This reflects on the score on appearance in which it was second to pulp juice (JP); first in flavour and mouth feel and again second in aroma after pulp-peel juice (JPP). Rind juice (JR) was rated least in all sensory parameters and was in overall least accepted (5.53) and was moderately accepted.

Table 3: Sensory Properties of Watermelon juices

Sample codes	Sample source	Appearance	Flavour	Aroma	Mouth feel	Overall acceptability
JWW	Whole fruit	7.92 ^c ±1.52	8.42 ^a ±0.98	7.29 ^b ±1.35	8.26 ^a ±1.28	8.57 ^a ±0.70
JP	Pulp	8.57 ^a ±0.70	7.46 ^c ±1.33	6.76 ^c ±1.24	7.46 ^b ±1.27	7.92 ^c ±1.19
JPR	Pulp/ Rind	6.38 ^d ±1.52	6.03 ^d ±2.08	5.88 ^d ±1.60	6.19 ^c ±1.95	6.69 ^d ±1.80
JPP	Pulp/ Peel	7.96 ^b ±1.11	8.03 ^b ±1.03	7.50 ^a ±1.60	8.26 ^a ±0.96	8.30 ^b ±0.88
JR	Rind	6.15 ^e ±2.25	4.57 ^e ±2.31	4.65 ^e ±2.39	4.26 ^d ±2.25	5.53 ^e ±2.17

Values are mean scores ± standard deviation of 25 panellists. Values in the same column bearing different superscript differ significantly ($p < 0.05$).

4. CONCLUSION

This research work studied the proximate properties of juice from whole watermelon and its fractions. As regards experimental design, sample JWW which was the juice gotten from blending the whole watermelon was more preferred among the other four samples. However, the sensory

scores suggest that the fruit juice is not the best formulation, but it can be enhanced to improve the appearance, flavour, aroma and mouth feel for it to be generally acceptable. It is observed that from the results obtained, the juice has little fat and no fibre as a result of the processing method used. It also shows that the energy values are low which indicates that watermelon juice are low energy juice which is of benefit to individuals with the intention of losing weight thereby reducing some cardiovascular diseases.

In classifying the acceptability of the watermelon juices in their decreasing order, we have; JWW>JPP>JP>JPR>JR.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

- 1.
- 2.
- 3.

REFERENCES

- Abu-Hiamed, H. A. (2017). Chemical compositions, flavonoids and β -sitosterol contents of pulp and rind of watermelon (*Citrullus lanatus*) fruit. *Pakistan Journal of Nutrition* **16**: 502-507.
- Akusu, O. M., Kiin-Kabari, D. B., Ebere, C. O. (2016). Quality characteristics of watermelon/pineapple fruit juice blends. *American Journal of Food Science and Technology* **4** (2): 43-47.
- Alam, M. K., Hoque, M. M., Morshed, F. A., and Sharmin, K. N. (2013). Evaluation of watermelon (*Citrullus lanatus*) juice preserved with chemical preservatives at refrigeration temperature. *Journal of Scientific Research* **5**:407-414.
- Al-Sayed, H. M. A. and Ahmed, A. R. (2013). Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. *Annual journal of Agricultural Science* **58**(1): 83–95.
- Ameh, B. A., Gernah, D. I., Obioha, O. and Ekuli, G. K. (2015). Production, quality evaluation and sensory acceptability of mixed fruit juice from pawpaw and lime. *Food and Nutrition science* **6**: 532-537.
- Asha, S., Nithisha, K., Niteesha, G., Bharath, K. R. and Ravikumar, V. (2014). Evaluation of microbial quality of street vended vegetable and fruit juices. *International Research Journal of Biological Sciences* **3** (3): 60-64.
- Association of Official Analytical Chemists, AOAC, (2010). Official methods of analysis 18th edition. *Association of Official Analytical Chemists*, Washington, DC. 10-30.
- Bello, O. O., Bello, T. K., Fashola, M. O. and Oluwadun, A. (2014). Microbial quality of some locally produced fruit juices in Ogun State, South Western Nigeria. *Journal of Microbiological Research* **2**: 1-8.
- Braide, W., Odiong, I. J., Oranusi, S. (2012). Phytochemical and antibacterial properties of the seed of watermelon (*Citrullus lanatus*). *Prime Journal of Microbiological Research* **2**(3): 99-104.
- Codex Alimentarius ??

- Costescu, C., Parvu, D. and Ravis, A. (2006). The Determination of some physico-chemical characteristics of orange grapefruit and tomato juices. *Journal of Agro Alimentary processes and Technologies* **12** (2): 429-432.
- Eke- Ejiofor, J., Banigo, E. B. and Victor- Uku, E. (2016). Product development, sensory and chemical composition of spiced watermelon juice. *International Journal of Biotechnology and Food Science* **4** (2): 15-21.
- FAO (2005). Codex general standard for fruit Juices and nectars. *Food and Agricultural Organization, Rome*.
- Grigoras, C. G. (2012). *Valorization des fruits et sous-produits de l'industrie de transformation des fruits par extraction des composés*.
- Hamzah, N., Wan Ishak, W. R. and Rahman, N. A. (2018). Nutritional and pharmacological properties of agro-industrial by-products from commonly consumed fruits. *Journal of Food Science and Technology* **3**(4): 1-21.
- Heyman, M. B., Abrams, S. A., Heitlinger, L. A. and Daniels, S. R. (2017). Fruit juice in infants, children and adolescents. *Journals Gateway pediatrics* **17**: 0967-0971.
- Ijah, U. J. J., Ayodele, H. S. and Aransiola, S. A. (2015). Microbiological and some sensory attributes of watermelon juice and watermelon- orange juice mix. *Journal of Food Research Science* **4** (3): 49-61.
- Iwe, M. O. (2010). *Handbook of Sensory Methods and Analysis*. pp.73-78. Enugu Nigeria.
- Jiménez- Sánchez, C., Lozano-Sánchez, J., Manti, N., Saura, D., Valero, M., Segura-carretero. A. and Fernández-Gutiérrez, A. (2015). Characterization of polyphenols, sugars and other polar compounds in persimmon juices produced under different technologies and their assessment in terms of compositional variations. *Food Chemistry Journal* **182** (1): 282-291.
- Naz, A., Butt, M. S., Sultan, M. T., Qayyum, M. N. and Niaz, R. S. (2014). Watermelon lycopene and allied health claims **13**: 650-666.

- Nirmal, K. S., Jiwan, S. S., Joźsef, B., James, S. B. W. and PilarCano, M. (2012). *Handbook of Fruits and Fruit Processing*.
- Northrop, J. H. (2011). A convenient method for the formol titration. Accessed at 15th April 2013.
- Ogunbanwo, S. T., Sado, A., Adeniji, O. and Fadahunsi, I. F. (2013). Microbiological and nutritional evaluation of watermelon juice (*Citrullus lanatus*). *Academic Arena* **5** (3): 36-41.
- Ohwesiri, M. A., David, B. K. and Caroline, O. E. (2016). Quality characteristics of orange/pineapple fruit juice blends. *American Journal of Food Science and Technology* **4** (2): 43-47.
- Okwori, E., Onu, R. O., Adamu, M., Chindo, H., Dikko, H., Odunze, I. I., Baidu, A. L., Natala, C. and Eze, P. (2017). Production and shelf life determination of fruit/vegetable juices using watermelon, cucumber, pineapple and carrot. *African Journal of Food Science and Technology* **8** (3): 034-039.
- Olayinka, B. U. and Etejere, E. O. (2018). Proximate and chemical compositions of watermelon (*Citrullus lanatus*) and cucumber (*Cucumis sativus* L. cv Pipino). *International Food Resource Journal* **25**(3): 1060-1066.
- Oxford University press (2018). <https://en.oxforddictionaries.com/definition/fruit>. Accessed 2nd March 2018.
- Pereira-Netto, A. B. (2018). Tropical fruits as natural exceptionally high sources of bioactive compounds. *International Journal of Fruit Science* **18**: 235-239.
- Rathnayaka, R. (2013). Antibacterial effect of malic acid against *Listeria monocytogenes*, *Salmonella enteritidis* and *Echerichia coli* in mango, pineapple and watermelon juices. *American Journal of Food Technology* **8** (1): 74-82.
- Singh, R.P. and McLellan, M. R. (2018) U. S. Department of Agriculture, Composition of Foods. *Agriculture Handbook* pp. 8-9.
- Sharma, A., Anand, N. and Singh, B. K. (2016). Fruit processing Industry in India: A short Review

Ugbogu, O. C and Ogodo, A. C (2015). Microbial flora, proximate composition and vitamin content of three fruits bought from local market in Nigeria. *International Journal of Chemical Engineering Application*. **6**(6): 440-443.

Ukeyima, K., Gernah, D. I., Ikya, J. K., Odess, R. and Ogunbaide, B. J. (2017). Addressing food security challenges through agro raw materials processing. *Agricultural science Research Journal* **3**: 6-13.

World Health Organization (2012). Increasing fruits and vegetables consumption to reduce the risk of non-communicable diseases.

UNDER PEER REVIEW