EFFECTS OF DIFFERENT PECTIN SOURCES ON SOME QUALITY PARAMETERS OF WATERMELON (*CITRULLUS LANATUS*) JELLY.

Linus-Chibuezeh, A[1]., C. J. Okoye[1]., O. Okorie[2]. and S. Kalu[2]

[1]Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Nigeria.

[2]Department of Food Science and Technology, Abia State University, Uturu, Nigeria

Email: linusadindu@gmail.com

ABSTRACT

Watermelon was used to produced jelly using pectin from different fruits (lime, lemon, orange, pineapple and grape), and jelly without the addition of pectin served as control. Physicochemical and proximate analysis were conducted on the jelly samples using standard methods, while sensory evaluated was conducted using 20 member panelists. Results showed for physicochemical: pH ranged from 3.28-3.63, TSS ranged from 60.39-67.27%, TTA ranged from 0.58-0.82%, brix content ranged from 17.53-25.78 and vitamin C ranged from 11.61-23.49. The proximate composition showed that moisture content range from 29.50 to 38.64%, ash ranged from 1.03 to 0.96%, crude protein ranged from 0.84 to 1.09%, crude fats ranged from 1.09 to 0.62%, the total solids ranged from 38.64 to 70.48%, carbohydrate ranged from 59.21 to 67.66% while crude fibre showed no value. Sensory evaluation showed that all the samples were acceptable to the panelists with respect to overall acceptability. The work also revealed that fruit waste can be utilized in jelly production.

Keywords: Pectin, Jelly, Physicochemical, Proximate, Sensory evaluation

INTRODUCTION

Jelly is a soft, semi-solid food substance with a resilient consistency made by the setting of a liquid containing pectin or gelatin, or by the addition of gelatin to a liquid especially such a substance made of fruit containing pectin boiled with sugar. Jelly can be made from sweet, savory or hot ingredients. It is made by a process similar to that for jam making, with the additional step of filtering out the fruit pulp after initial heating. Jelly is an appropriately gelled mixture of sugars and juice and/or aqueous extracts of one type of fruit or two or more types of fruits, jellies are made from fruit juice devoid of solid particles (Okaka 2005). Jellies are usually made from fruits that have high natural pectin, although the use of additional pectin will help guarantee that a gel is formed (Wind, 2010). Good jelly is clear and sparkling, and has a fresh flavor of the fruit from which it is made. It is tender enough to quiver when moved, but hold angles when cut (Middletown, 2011).

Ideally, fruits for jelly production should contain sufficient pectin and acid to yield good jelly, because pectin is virtually contained in all fruits and can be extracted. Jelly if properly processed and stored in an air tight container can stay for more than one year if not opened and six months if opened but refrigerated (Taouk, 2007). Pectin refers to the group of diverse complex polysaccharides found in the primary cell wall and intercellular space (middle lamella) of plant cells. It is abundant in young tissues and is the characteristics constituents of fruits (Ihekoronye and Ngoddy 1985). Pectin is a highly molecular polymeric carbohydrate which is present in all plants (Kringelum, 1995). It is a purified carbohydrate product generally obtained from the acid extraction of the inner portion of citrus peels and apple pomace (Meloan and

Pomeranz, 1980). It is responsible for the gelling of boiled fruits preparations (Macrae *et al.,* 1993). As a stabilizer, it is important in several manufactured products such as jelly, pectin in foods prevents separation of various ingredients of the mix (Okaka and Okaka 2001). Fruits are usually consumed fresh, however, due to the fact that they are highly perishable and seasonal in nature, large quantities are processed particularly in developed countries. Examples of fruits are watermelon, orange, guava, tangerine, mango, cherry, pineapple etc (Frazier, 1998). Although watermelon is commonly referred to as fruits, but they are really vegetable. Fruits like watermelon are loaded with antioxidants which are associated with a decrease risk of prostate cancer and cervical cancers, fight heart disease and protect the body against molecular degeneration, apart from the supply of vitamins, their chief function as foodstuffs is to provide the protective substances, roughages *etc.* (Mao, 2011). Watermelon (*citrullus lanatus*), is a tropical fruit that is mainly eaten in its raw form. However, its consumption pattern in many developed countries especially USA, has shifted from fresh fruit to the processed forms like jelly, wine, jam, preserves etc. for increased convenience, year round availability, and uniform quality (Blomberg, 2004), unlike countries like Nigeria, where it is consumed fresh and raw due inadequate processing technologies. Watermelon is one of such fruits mostly affected by post harvest deterioration (PHD), owing to its high perish-ability because of high content of water which contributes to about 99% of the total weight. Nutritional, Watermelon is rich in carotenoids including lycopene, phytoene, beta-carotene, lutein and neurosporene (El-adawy and Taha, 2001). Lycopene made up the majority of the carotenoids in watermelon. The carotenoid content varies depending on the variety of the watermelon. Depending on the variety, carotenoid content in red fleshed watermelon varies from 37-121mg/kg fresh weight, where as lycopene varies from 35-112mg/kg (El-adawy and Taha, 2001). And the amino acid citrulline has also been isolated from watermelon (Mandel *et al.,* 2005). Watermelon seeds are excellent source of protein (both essential and non-essential amino acids) and oil. The seed contains about 35% protein, 50% oil and 5% dietary fibre; it is also rich in micro- and macro nutrients such as magnesium, calcium, potassium iron, phosphorous and zinc (El-adawy and Taha, 2001). In most developing countries with Nigeria inclusive, pectin is imported from Europe, United States of America and other parts of the world. This research would seem to be a good market for supplying local fruit process with pectin to substitute for imports. In addition, there is the need to investigate the potentials of other tropical fruits like watermelon which is abundant but currently underutilized in commercial jelly production. Therefore, the objectives of this study are to produce jelly using watermelon fruit juice, evaluate the effectiveness of pectin from different sources orange, lime, lemon, grape and pineapple to produce quality jelly and compare the physicochemical, proximate and sensory qualities of the jellies produce.

MATERIALS AND METHODS

The raw materials which include (lemon, lime, orange, grape and pineapple) and watermelon were purchased from Ubani main market in umuahia, Abia State, while reagents and other materials were sourced from central laboratory of National Root Crop Research Institute (NRCRI) Umudike, Abia State, Nigeria.

Preparation of Pectin from Different Fruit

The fruits (lemon, lime, orange, grape and pineapple), were sorted to remove deteriorated ones. They were washed thoroughly with clean water, weighed, peeled, and the peels oven-dried. The dried peels were blended with a super interment electric blender (SB-242, Sonik, Japan) and sieved to obtain fine powder, which was weighed and stored in clean dry containers till further use.

Preparation of Sugar Syrup

Three hundred (300ml) milliliters of clean water was added to two hundred and eighty (280g) grams of sugar. It was allowed to boiled for 10 minutes, and 4 grams of citrus acid added, it was allowed to boil again until a slippery feel of gel was formed, after it was put off from the heat generator and allowed to cool.

Processing of Watermelon Jelly Using Pectin from Different Fruits

The watermelon fruit was washed with clean water and cut into small sizes. The seeds were carefully removed with knife; it was then peeled and blended with a super interment electric blender (SB-242, Sonik, Japan). The juice was sieved with muslin cloth and kept in a clean bowl.

Jelly Production

One hundred and eighty (180g) grams of the fruit juice was concentrated and the prepared sugar syrup was added on boiling, followed by the addition of pectin. It was allowed to boil with constant stirring until it gelled. The gelation temperature and time were taken. The same procedure was followed for all the different pectin produced. The prepared jellies were carefully poured into steam sterilized bottles and covered immediately. The above procedural steps were carefully followed for the production of another jelly, with exceptional step of pectin addition, this served as the control.

Physicochemical Analysis of Watermelon Jelly

pH

The pH of the jelly sample was measured directly using a pH meter (Jens way modal). Twenty milliliters of the samples was put in a fifty milliliters glass beaker. The electrodes of the pH meter was rinsed and put inside the jelly, and the pH reading was read directly from the screen of the meter when the point became steady.

Determination of Total Soluble Solids (TSS)

This was determined using AOAC (1995) method. Two milliliters of the sample was measured with a previously weighed evaporating dish. The dish and sample content was put in a carbolyte moisture extraction oven at 105 °C. The sample was evaporated to dryness and dried to a constant weight. It was allowed to cool in a dessicator and reweighed. By weight difference, the weight of soluble solids in the sample was determined and expressed as the percentage of the sample weight. The total soluble solid was given by;

%TSS= $(w_2\text{-}w_1)100$/volume of sample.

Determination of Total Titratable Acidity (TTA)

This was carried out in accordance with the method described by AOAC (1995). Distilled water (100 milliliters) was put into a conical flask. Five milliliters of the sample and five drops of phenolphthalein (indicator) were added to the conical flask. The mixture was titrated against 0.01N solution of sodium hydroxide (NaOH). The end-point was reached when colour change was observed, after adding drops of NaOH solution.

%titratable acidity = average titre × 0.09.

Brix Determination (%Sugar)

The total sugar content of the sample was determined using the Anthrone method described by Ojiako and Akubugwo (1997). Standard glucose solution (10mg/100ml) was prepared and diluted serially to obtain dipparent concentration of glucose solution. Five millilitres of each diluent was measured into separate test tubes. Similarly, 1.0 millilitre of each prepared test samples measured with separate test tube. Each of the separate test tubes containing two millilitres of the extracts was treated with six millilitres of Anthrone reagent. All the test tubes were boiled for ten minutes with covers, so as to prevent evaporation. The absorbance of the developed colour solution in each case was read in a spectrophotometer at 620nM. From the reading of the standard glucose solution, a standard graph was plotted and used to extrapolate the sugar content of each of the test samples.

%sugar= X×F

Where; X= concentration of curve and F= experimental factor.

Determination of Vitamin c Content

The vitamin C content of the samples was determined by the Barackat titrimetric method. Twenty grams of each sample was homogenized in one hundred millilitres of EDTA/TCA extraction solution, by blending for five minutes. The homogenate was filtered and the filtrate used for the analysis. Filtrate for each test sample was passed through a packed cotton wool containing activated charcoal to remove the colour. The volume of the filtrate was adjusted to one hundred millilitres by washing with more of the extraction solution. Twenty millilitres of each filtrate was measured into a conical flask, ten millilitres of potassium iodide solution was added to each of the flask followed by five millilitres of starch solution (indicator), and the mixture was titrated against 0.01 millilitres of copper II tetra sulphate IV solution.

Proximate Composition

Moisture, fat, crude fibre, crude protein and ash were evaluated by method of AOAC (1995), while carbohydrates was calculated by difference (James, 1995).

Sensory Evaluation of the Watermelon Jelly

Sensory evaluation of the jelly samples was conducted using a randomly selected 20-member panel (Iwe, 2010). The sensory quality attributes of the samples tested include colour, taste, aroma, spreadability, gelation, mouthfeel and general acceptability. In the questionnaire, the panellists were required to observe and taste each sample as coded and grade them on a 9-point hedonic scale which ranged from like extremely for 9 to dislike extremely for 1, with 5 as neither like nor dislike (Iwe, 2010).

Statistical Analysis

Data from this work were subjected to analysis of variance (ANOVA) using Statistical Program for Social Science version 21.0 (IBM SPSS Inc., Chicago, IL). Means were separated using the Turkey's test (Ihekoronye and Ngoddy, 1985).

DISCUSSION

The Physicochemical Properties of Watermelon Jelly.

The result of the physicochemical analysis of the watermelon jelly is presented in table 1.

The pH of the jelly samples ranged from 3.28 – 3.63, which is slightly higher than the set standard for jams and jellies 3.1 – 3.2 (Smith, 2006), with sample DZY having the closet value (3.28) to the standard, and this showed that the samples are acidic. Sample WWB (control and without pectin) has the highest pH value, this result also agreed with the findings of Smith (2006), that pectin added to jelly sample lowers the pH and acidity of the sample. However, since the pH of jelly samples can be used to determine the type of pectin as well as gel firmness, it can be deduced here that the pectin produced from lime, orange, pineapple, lemon and grape are low-methoxyl pectin (slow-set), as their pH is not up to 3.6 for rapid set pectin used for jams and preserves (smith, 2006). The acidic level could also be attributed to the added citric acid for preservation of the samples.

The TTA of the samples ranged from 0.5 to 0.82%. This value correlates to TTA values recorded for jelly by Verma and Joshi, (2001) of 0.5 to

1.0%. It can also be deduced from Table 1 that acidity increases with decrease in pH.

Total soluble solids (TSS) of the jelly samples (Table 1) increased with addition of pectin. Sample ADF (lime pectin) recorded mean value of 67.27%, which is the highest in the series, this is in accordance with the results of Philips and Williams (2000), which reported that pectin from lime yield good gel and gives other benefits to the final product. TSS ranged from 60.39 to 67.27% and sample WWB has the lowest value of 60.39%. However, the value of TSS agreed with standard TSS for jam and jelly, which is within 65-68%, (Azam-Ali, 2009). Sample WWB differed significantly from the others at $p \leq 0.05$.

Brix content measures the residual sugar level of a sample. Brix ranged from 17.53 to 25.78%. Sample with pectin from pineapple have the highest mean value of 25.78%. This may be because of high content of sugar in pineapple, orange pectin followed with mea value of 24.31%, then lemon with 21.77%, while grape and lime has 19.64 and 18.56% respectively and sample without pectin has the lowest mean value of 17.53%.

The vitamin C content of the samples ranged from 11.61 to 23.49mg/100. These showed that the samples have a reasonable quantity of vitamin C. These may be as a result according to Howstuffwork, (2009), that watermelon is an excellent source of vitamin C. From this result, it can be deduced also that the vitamin C content increased with addition of pectin, with Vitamin C content of pectin from pineapple having the highest mean value of 23.49mg/100 and that without pectin with a value of 11.61mg/100g.

Table 1: Mean Values of Physiochemical Results of Watermelon Jellies from Different Pectin Source

Sample/ Treatment	Grape FOA	Lemon DZY	Orange QPG	Pineapple OFG	Lime ADF	Control WWB	LSD
pH	3.35^{e}±0.01	3.28^{f}±0.01	3.43^{d}±0.04	3.48^{b}±0.04	3.47^{c}±0.01	3.63^{a}±0.04	0.011
TTA (%)	0.77^{b}±0.01	0.62^{a}±0.03	0.73^{c}±0.01	0.65^{d}±0.01	0.82^{e}±0.01	0.58^{f}±0.01	0.01
TSS (%)	62.91^{e}±0.01	65.47^{b}±0.02	63.63^{d}±0.04	64.47^{c}±0.02	67.27^{a}±0.04	60.39^{f}±0.01	0.032
Brix	19.64^{d}±0.02	21.77^{c}±0.01	24.31^{b}±0.01	25.78^{a}±0.02	18.56^{e}±0.06	17.53^{f}±0.12	0.043
Vitamin C (mg/100g)	19.53^{e}±0.12	19.65^{d}±0.21	21.64^{b}±0.02	23.49^{a}±0.01	13.53^{c}±0.12	11.61^{f}±0.01	0.30

Values are means ± standard deviation of triplicate determinations. Means bearing different superscript on the row are significantly different at $p<0.05$. Where FOA= jelly made with pectin from grape, DZY = jelly made with pectin from lemon, QPG = jelly made with pectin from orange, OFG = jelly made with pectin from pineapple, ADF = jelly made with pectin from lime, while WWB = control with pectin

Proximate composition result of jelly samples.

The result of the proximate composition of the watermelon jelly samples are showed in Table 2. The result of the proximate analysis showed that the percentage moisture content of the samples ranged from 29.53 to 38.64%, this range is within range as described by Mayhew, (2008). However, the samples differed significantly in their moisture content at $p\leq0.05$ probability level, with sample without pectin (control) having the highest mean value of 38.64% and sample produced from lime pectin with 29.53%. The high moisture recorded for the samples implied that packaging materials for jelly products should be air tight and this also advocates for addition of preservatives, so the samples could last longer. The percentage ash content of the samples varied from 0.03 to 0.95%, this revealed that the samples are low in mineral content. The crude fat of the samples are low ranging from 1.09 to 0.63%, this can be attributed to the fact that most fruits are low in fat content (Lannelli, 2008). The samples are also low in protein content ranging from 0.84 to 1.09%, which is also supported by findings of Lannelli, (2008), with sample WWB having the lest mean value and ADF has the highest mean value in protein content. The carbohydrate content of the samples ranged from 59.21 to 67.66%. The samples are fairly high in carbohydrate, and these values are substantially supported by Dolson (2008), who stated that fruits are mainly made up of carbohydrates. The sample without pectin has the lowest mean value of 59.21%, this was also supported by the statement of Thomas (2002), that addition of fruit peels (pectin) during jelly making may increase the dietary fibre content of the finished product and that the aroma and other biochemical content may also get improved. The result also showed that the samples do not contain crude fibre.

Table 2: Mean Proximate Results of Watermelon Jellies

Sample/Treatment	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fibre (%)	Carbohydrates
Grape pectin FOA	32.81^{d}±0.07	1.03^{f}±0.03	0.46^{e}±0.01	0.85^{e}±0.02	ND	64.85^{c}±0.04
Lemon pectin DZY	31.46^{e}±0.37	1.08^{e}±0.04	0.60^{b}±0.02	0.90^{d}±0.01	ND	65.96^{b}±0.01
Orange pectin QPG	34.63^{c}±0.04	1.42^{c}±0.01	0.58^{c}±0.01	1.02^{c}±0.03	ND	62.36^{e}±0.02
Pineapple pectin OFG	35.84^{b}±0.03	0.95^{a}±0.02	0.63^{a}±0.02	1.05^{b}±0.01	ND	61.54^{d}±0.01
Lime pectin ADF	29.53^{f}±0.12	1.19^{a}±0.08	0.54^{d}±0.01	1.09^{a}±0.01	ND	67.66^{a}±0.11
Control No pectin WWB	38.64^{a}±0.02	0.89^{b}±0.02	1.09^{f}±0.00	0.84^{f}±0.01	ND	59.21^{f}±0.07
LSD	1.00	0.072	0.013	0.020	-	0.990

Values are means± standard deviation of triplicate determination
Means bearing different superscript on the same row are significantly different $P<0.05$. ND = Not detected. Where FOA= jelly made with pectin from grape, DZY = jelly made with pectin from lemon, QPG = jelly made with pectin from orange, OFG = jelly made with pectin from pineapple, ADF = jelly made with pectin from lime, while WWB = control with pectin

Sensory Evaluation Result of Watermelon Jelly

The result for the sensory evaluation is presented in Table

The results obtained from this work revealed that jelly

produced with pineapple pectin (OFG) rated highest in terms of colour attribute with a mean value of 8.1, while that produced with pectin from grape (FOA) rated lowest with mean value of 7.0. However, there was no significant difference between jelly samples WWB (control, without pectin), 8.0± and sample OFG 8.1 at $p \leq 0.05$.

In taste, there was no significant difference in jelly samples FOA, QPG, DZY, OFG and WWB, with mean values of 7.2, 7.3, 7.6, 7.8 and 7.5 respectively, tested at 5% level of probability ($p > 0.05$), but significant difference exist between them and sample ADF with a mean value of 5.2 at ($p \leq 0.05$). This showed that origin of pectin did not affect the taste of the jellies adversely.

Origin of pectin did not affect the spreadability and aroma quality attributes of the sample. However, there was significant difference ($p \geq 0.05$) between jelly sample ADF 7.8 and WWB 5.6 in gelability. Jelly samples FOA and DZY showed no significance ($p \geq 0.05$) mean values of 7.0 and 6.8 respectively, while samples QPG and OFG showed no significance ($p \geq 0.05$) with values of 6.6 and 6.4 respectively.

All the samples showed no significant different ($p \geq 0.05$) in mouthfeel sensory attribute. However, sample QPG with mean of 8.1 rated highest in terms of mouthfeel attribute.

In the overall acceptability, sample QPG with a mean value of 8.0, and samples DZY and OFG with mean values of 7.7 and 7.5 respectively which approximates to 8 and translates to liked very much on the sensory scale received highest rating in overall acceptability attribute. Sample ADF was the least accepted sample with mean value of 6.4 translates to like slightly on the sensory scale, this could be attributed to its high acidic content of 0.82% which contributed to the slight bitter taste of the sample. Philips and Williams (2000) also reported reduced acceptance of jam from lime pectin. However, acceptable jelly samples were produced and liked by the panelists irrespective of the pectin origin Table 3. The results obtained corresponds with Oluwole (2009) who stated that general/overall acceptability is the combination of all the other sensory parameters and if a product records acceptable quality levels in most of the other parameters, it is expected that such product will have a good overall acceptability.

Table 3: Mean sensory scores of watermelon jelly different pectin sources

Sample/treatment	ADF Lime pectin	FOA Grape pectin	QPG Orange Pectin	DZY Lemon pectin	OFG Pineapple Pectin	WWB Control No pectin	LSD
COLOUR	7.9±0.94^{ab}	7.0±0.89^{c}	7.7±0.78^{abc}	7.1±0.94^{bc}	8.1±0.83^{a}	8.0±1.18^{a}	0.3744
TASTE	5.2±1.66^{b}	7.2±1.17^{a}	7.3±1.34^{a}	7.6±1.11^{a}	7.8±1.08^{a}	7.5±1.11^{a}	1.7659
AROMA	5.3±1.41^{a}	6.6±1.28^{a}	6.3±1.60^{a}	7.0±1.41^{a}	6.6±1.62^{a}	6.5±0.92^{a}	1.9244
SPREADIBILITY	6.8±0.98^{a}	7.1±0.53^{a}	7.2±0.17^{a}	7.3±0.90^{a}	7.6±0.91^{a}	7.3±1.27^{a}	1.3671
GELABILITY	7.8±0.87^{a}	7.0±1.18^{ab}	6.6±0.91^{bc}	6.8±1.40^{ab}	6.4±1.36^{bc}	5.6±1.11^{c}	1.6004
MOUTHFEEL	6.9±1.44^{a}	7.4±1.42^{a}	8.1±0.83^{a}	7.7±0.90^{a}	7.6±1.11^{a}	6.8±0.87^{a}	1.5621
OVERALL ACCEPTABILITY	6.4±1.36^{c}	7.1±1.13^{abc}	8.0±0.89^{a}	7.7±0.78^{ab}	7.5±1.69^{ab}	5.00±0.78^{bc}	1.5621

Values are means ± standard deviation of twenty panelists.

Means bearing different superscript on the row are significantly different at $P \leq 0.05$.
Where FOA= jelly made with pectin from grape, DZY = jelly made with pectin from lemon, QPG = jelly made with pectin from orange, OFG = jelly made with pectin from pineapple, ADF = jelly made with pectin from lime, while WWB = control with pectin

CONCLUSION

Jellies produced from watermelon juice with pectin from different sources (lime, lemon, orange, pineapple and grape) are of good qualities. The results obtained from the analysis showed that all the samples have good attributes. Pectin processed from waste of common fruit helped to form good gels for jelly production, as their qualities as evaluated bested that without pectin. Sensory evaluation showed that all the jelly samples prepared from different pectin sources produced quality jellies that were accepted in terms of overall acceptability quality attribute.

This work has also demonstrated practically that waste from most fruits which ordinarily would constitute environment nuisance can be harnessed to food processing, and thereby reduce import duties on pectin important and conserve foreign reserves. This will add to varieties of jelly in the market, and also reduce post harvest deterioration (PHD) associated to watermelon.

REFERENCES

Association of Official Analytical Chemists (A. O. A. C. 1995). Official methods of analysis Vol. 16th editions, Washington D.C.

Azam-Ali, S. (2009). Testing for the end-point of jam. A food processing training course in Bangladesh. Retrieved from http//:practicalaction.com. 2009/21/03.

Blomberg, M. (2004). In season: savory summer fruits "the Gainesville sun. Retrieved July 17, 2005.

Dolson, L (2008). The most common low carbohydrate misconception. Updated Jan., 26, 2008 from http://www.about.com.

El-Adawy, T.A and Taha, K. M. (2001). Characteristics and composition of watermelon, pumpkin and paprika seed oil and flour. Journal of Agriculture and Food Chemistry, 49(3), 1253-1259.

Frazier, W.C (1998). Food microbiology 2nd edition: Tata M.C Grand Hill publishing company LTD, Bombay, New Delhi pp363.

Howstuffworks, (2009). Health benefits of watermelon. Retrieved from http://homehowstuffworks.com/watermelon3.htm. accessed 21/07/2010

Ihekoronye, A.I and Ngoddy, P.O (1985). Integrated food science and technology for the tropics. Macmillan press publisher pp10-26, 293-300.

Iwe, M. O. (2010). *Handbook of Sensory Methods and Analysis*. 2nd Edition. Rojoint Communication Services Ltd, Enugu, Nigeria.

James, C.S. (1995). Analytical chemistry of foods. Chapman and Hall inc. New York.

Lannelli, V (2008). Low fat foods. Child nutrition basics, retrieved from http://www.childnutrition.com. 03/13/2008.

Macrea, R. Robinson, R.K and Salder, M.J (1993). Encyclopedia of food science, food technology and nutrition vol.4 academic press ltd, London, pp2273.

Mandel, H., Levy, N., Izokovitch, S.I and korman, S.H (2005).elevated plasma cittrulline and arginine due to consumption of icitruulus lanatus (watermelon) "berichte de deutschem chemischen Gresellschaft28 (4):467-472.

Mao, K (2011). Entry posted in foods, natural health dictionary.

Mayhew, M (2008). Jams, jellies and marmalades: step by step recipes for home preservation. Annes publishing ltd, London.

Middletown, G.F (2011). Section 4. Fruit and nut butter, jams and jellies.

Meloan, C and Pomeranz, Y (1980). Pectin in: food analysis laboratory experiment, 2nd edition AVI publisher co. inc Westport Connecticut USA pp136-137.

Ojiako, O.A. and Akubugwo, E.I (1997). An introductory approach to practical biochemistry. Crc publications Owerri pp133.

Okaka, J.C (2005). Handling, storage and processing of plant foods. OcJanco academic publisher Enugu.

Okaka, J.C and Okaka, A.N.C. (2001). Foods: composition, spoilage and preservation. OcJanco academic publisher Enugu pp192-217.

Oluwole, A. (2009). Sensory Evaluation of Foods. In: *Quality Control for the Food Industry. A Statistical Approach.* Concept Publications Limited, Lagos Nigeria. Pp 229-235.

Smith, D. (2006). Fruit jellies, food processing for entrepreneurs series. Vol. 3 pp66.

Taouk, J (2007). My handbook on food quality and hygiene control. Coudeau catering Nigeria ltd Portharcout, Nigeria pp38.

Thomas, M (2002). Best kept secrets of the women institute; jams, pickles and chutney (1st edition) ISBN 074322173.

Reference to this paper should be made as follows: Linus-Chibuezeh, A., (2017), Effects of Different Pectin Sources on Some Quality Parameters of Watermelon (*Citrullus Lanatus*) Jelly.*J. of Medical and Applied Biosciences,* Vol. 9, No. 2, Pp. 52-69