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Technical Parameters Affecting the Production of Soursop (*Annona muricata)* Juice

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Abstract.

Soursop (*Annona muricata)* is one of the exotic fruits prized for its very pleasant,sub-acid, aromatic and juicy flesh juice. It softens very rapidly during ripening and becomes mushy and difficult to consume fresh. Freshly expressed juice, is highly susceptible to spoilage, in fact more so than whole fruit. In the present study, various technical parameters influencing to production of soursop (*Annona muricata)* juice were clearly investigated such as ratio of pulp: water, sugar addition during the blending process; pasteurization, storage condition to stability of soursop juice. Optimal results showed that ratio of pulp: water (1.0: 2.0 w/v); 9% of sugar addition; 95^{o}C, 30 seconds in pasteurization; 28^{o}C within 6 weeks of preservation could maintain stability of soursop juice.

Keywords: *Soursop, juice, sugar, pasteurization, preservation, stability*

I. INTRODUCTION

The soursop plant is cultivated mainly in home gardens. The tree yields up to 10 tons/ha and each fruit weighs 0.5 to 2 kg. The skin is dark-green in the immature fruit, becoming slightly yellowish-green before the mature fruit is soft to the touch. In aroma, the pulp is somewhat pineapple-like, but its musky, subacid to acid flavor is unique. Many bioactive compounds and phytochemicals have been found in *A. muricata* and its many uses in natural medicine have been validated by many scientific researches. The fruit and fruit juice is taken for worms and parasites, to cool fevers, to increase mother's milk after childbirth (lactagogue), and as an astringent for diarrhea and dysentery (René G. Degnon et al., 2013). Soursop is loaded with nutrients such as amino acids, ascorbic acid, calcium, carbohydrates, iron, phosphorus, thiamine, fibres and riboflavin which can inhibit parasites inside the body. These are vital for the overall development of the body (Amusa NA et al., 2003). It is rejected at market because of external injury, or uneven shape and size (Umme et al., 2001). The fruit is usually eaten raw but it has been processed into different forms such as the puree, juice, jam and into jellies (Ajayi AA et al., 2015). Soursop juice is highly encouraged (Nwachukwu E, Ezeigbo CG, 2013). Soursop juice has many therapeutic properties which includes diuretic, antiurethritis, antihaematuria, antiantibacterial, anticancerous, astringent, sedative, and anti-aging (Eka Prasasti Nur Rachmani et al., 2012; Elavarasan K. et al., 2014; Puran Bridgemohan et al., 2015; Arif Kusumo Rahardjo, Moch Istiadjid Eddy Santoso, 2016; Mithun Pai B.H et al., 2016; Prasetyorini Djarot, Moerfiah Badar, 2016; Sejal Patel et al., 2016; Evy Sulistyoningrum et al., 2017; Khairun Nisa Berawi et al., 2017; Lili Indrawati et al., 2017; Uno UU et al., 2017; Banerjee A. et al., 2018; Islam Rady et al., 2018). They contain large amounts of antioxidants, vitamins C and E and the juice possess pleasant taste and aroma (Abbo ES et al., 2006). The properties and actions of soursop mostly documented by traditional uses were its ability to lower high blood pressure (Kumar S et al., 2015). Once the juice has been extracted and placed in storage it will need considerable treatment before being acceptable to the consumer (Emmanuel S. Abbo et al., 2006). Freshly expressed juice, is highly susceptible to spoilage, in fact more so than whole fruit. Unprotected by skin or cell walls, fluid components are thoroughly mixed with air and microorganism from the environment. Thus, unheated juice is subject to rapid microbial, enzymatic, chemical and physical deterioration. The goal of processing is to minimizing these undesirable reactions while still maintaining and in cases enhancing, the inherent quality of the starting fruit (Bates et al., 2001).

Several researches mentioned to production of soursop fruits. Storage stability of soursop (*Annona muricata* L.) juice at refrigeration (4°C) and ambient (28°C) temperatures was studied (Emmanuel S. Abbo et al., 2006). The microbiological and nutritional characterization of Soursop pulp (*Annona muricata* L.) was investigated (René G. Degnon et al., 2013). Nwachukwu et al., (2013) observed changes in the microbial population of pasteurized soursop juice treated with benzoate and lime during storage**.** An instant granule drink from soursop (*Anonna muricata* Linn) fruit juice was investigated. The granule obtained from soursop fruit juice has very good physical characteristics, colored white, has fresh sweet and sour taste with the typical smell of soursop fruit (Prasetyorini Djarot, Moerfiah Badar, 2017). A new formulation of the concentrated fruit juice beverage from soursop juice and grapefruit peel was produced (Nguyen Phuoc Minh, 2017).

In the present study, various technical parameters influencing to production of soursop (*Annona muricata)* juice were clearly investigated such as ratio of pulp: water, sugar addition during the blending process; pasteurization, storage condition to stability of soursop juice.

II. Materials And Method

2.1 Material

We collected soursop fruit in Mekong river delta, Vietnam. They must be cultivated following VietGAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Fruits were washed thoroughly under turbulent washing to remove dirt, dust and adhered unwanted material. Besides soursop fruits we also used other materials during the research such as sugar, Petrifilm-3M. Lab utensils and equipments included pH meter, refractometer, viscometer, blender, thermometer, oven, refrigerator, incubator, colony counter.

Figure 1. Soursop (*Anonna muricata*)

2.2 Researching procedure

2.2.1 Effect of water addition (pulp: water) during the blending process

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water was added in different ratio (1:1 w/v, 1:1.5 w/v, 1:2 w/v, 1:2.5w/v, 1:3 w/v) of (pulp/water) to facilitate the blending process. Viscosity, sensory measurements were applicated to demonstrate the optimal ratio of pulp: water.

2.2.2 Effect of sugar addition

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water was added in 1:2 w/v. Different amount of sugar (3%, 5%, 7%, 9%, 12%) was added to the soursop juice. Viscosity, sensory measurements were applicated to demonstrate the optimal ratio of sugar addition.

2.2.3 Effect of pasteurization

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water and sugar were added in 1:2 w/v and 9% respectively. Soursop juice was pasteurized in different condition (80^{o}C, 60 seconds; 85^{o}C, 50 seconds; 90^{o}C, 40 seconds; 95^{o}C, 30 seconds and 100^{o}C, 20 seconds). Viscosity, sensory, microbial measurements were applicated to demonstrate the optimal condition of pasteurization.

2.2.4 Effect of storage condition to stability of soursop juice

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water and sugar were added in 1:2 w/v and 9% respectively. Soursop juice was pasteurized in 95^{o}C, 30 seconds. Pasteurized soursop juice was store under refrigeration temperature (4°C) and ambient temperature (28°C) for 6 weeks. Samples were analysed for brix, titratable acidity (g citric acid/100 g), pH, aerobic mesophilic bacteria and moulds/yeasts counts and *coliform* counts at regular intervals of one week.

2.3 Physico-chemical and biological analysis

Soursop juice was filtered on a cotton cloth and the volume (yield) of juice obtained from each sample was measured using a 500 ml volumetric flask.

The moisture, crude protein (N x 6.25), crude fat and ash contents of soursop pulp and soursop juice were determined using relevant AOAC methods (AOAC, 1984). Titratable acidity (g citric acid/100 g) and pH of the samples were determined according to the methods described by Egan et al. (1981).

Total soluble solids (TSS) were measured by refractometer. The viscosity measurement was made by using a viscometer. For sensory evaluation of the juices, the product was evaluated by a panel of 30 semi trained panelists. Panelists were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). 3M-Petrilm was used to analyze TPC, *Coliform, E. Coli*.

2.4 Statistical analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. Result & Discussion

3.1 Nutritional composition in soursop pulp and soursop juice

Nutritional composition in soursop pulp was primarily examined. Results were elaborated in table 1.

Table 1. Nutritional composition in soursop pulp

Parameter	Soursop pulp
Moisture (%)	23.28±0.01
Fat (%)	2.47±0.03
Protein (%)	7.37±0.02
Ash (%)	2.19±0.01
Carbohydrate (%)	22.94±0.01
Brix (^{o})	12.06±0.02
pH	4.70±0.03
Acidity (g citric acid/100g)	1.60±0.02

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 1 gave the physicochemical composition of soursop pulp and soursop juice. The values for the composition of soursop and the juice were similar to those given by Emmanuel S. Abbo et al., (2006). They showed that there were decreases in the fat, protein, ash, carbohydrate and acid content of the soursop juice, while increases were observed for moisture content, brix and pH of soursop juice compared to the pulp. This showed that processing affects the physical and chemical composition of the soursop.

The microbiological and nutritional characterization of Soursop pulp (*Annona muricata* L.) was investigated. The moisture content was ranged from 18.33 to 24.53%. The pH was between 4.1 and 4.8 with a mean acidity of 1.75%. The soursop pulps are rich in nutrients such as carbohydrates (23.05%), proteins (7.41%), ash (2.22%) and fiber (24.73%). All samples analyzed were rich in minerals such as phosphorus, calcium, magnesium, potassium and sodium, with a higher content of potassium (1.29 to 1.35%). Anti-nutritional factors such as oxalate and phytate were detected in samples, and values were lower than established toxic level. The total flora count of samples from markets ranged from 2×10^1 to 7×10^1. The enumeration of total coliforms and fecal coliforms was less than 10 cfu/g with an absence of pathogens. The results of physicochemical parameters of soursop puree during storage shown that moisture content, pH and acidity were 21.53±0.14%, 4.1±0.03 and 0.22±0.01%. These physicochemical parameters were significantly ($p < 0.05$) influenced by the storage time in unpasteurized puree. However, in pasteurized puree, the stability of physicochemical parameters is observed for 15 days of storage at 25°C. However, due to the fact that the soursop fruit is rich in nutrient and have high moisture content, which would encourage microbial growth and so deterioration, more attention should be paid to its microbial quality (René G. Degnon et al., 2013).

3.2 Effect of water addition (pulp: water) during the blending process

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water was added in different ratio (1:1 w/v, 1:1.5 w/v, 1:2 w/v, 1:2.5w/v, 1:3 w/v) of (pulp/water) to facilitate the blending process. Viscosity, sensory measurements were applicated to demonstrate the optimal ratio of pulp: water. From table 2, the optimal ratio of pulp: water should be 1.0: 2.0.

An instant granule drink from soursop (*Anonna muricata* Linn) fruit juice was investigated. The granule obtained from soursop fruit juice has very good physical characteristics, colored white, has fresh sweet and sour taste with the typical smell of soursop fruit. Other physical characteristics of the granule were it has 2.9% water content (<5%), 1.91 % ash content, 3.13 ml/s solubility, 29.3% angle of repose, and stable in the storage at 15 °C for two months. The granule produced from the juice of soursop fruit has acceptable physical features and proved effective to decrease high blood pressure, hence the soursop granule could be produced as an antihypertensive instant fruit drink in an industrial scale to substitute synthetic antihypertensive drugs (Prasetyorini Djarot, Moerfiah Badar, 2017).

3.3 Effect of sugar addition

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water was added in 1:2 w/v. Different amount of sugar (0%, 3%, 5%, 7%, 9%, 12%) was added to the soursop juice. Viscosity, sensory measurements were applicated to demonstrate the optimal ratio of sugar addition. From table 3, the optimal sugar addition should be 9%.

Nguyen Phuoc Minh (2017) created a new formulation of the concentrated fruit juice beverage from soursop juice and grapefruit peel. Our results showed that ratio of soursop juice: water (30%:70%), grapefruit peel supplementation (15%), carrageenan 0.3%, and final beverage concentration (65oBx) were approriated for its preservation

Table 2. Effect of water addition (pulp: water) during the blending process

Pulp: water (w/v)	1.0: 1.0	1.0: 1.5	1.0: 2.0	1.0: 2.5	1.0: 3.0
Viscosity (cp)	1,214±0.12^a	1,135±0.22^b	1,094±0.31^b	997±0.20^c	954±0.36^d
Sensory score	5.39±0.02^c	6.11±0.03^b	7.35±0.01^a	4.29±0.03^d	3.15±0.01^e

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3. Effect of sugar addition

Sugar addition	0%	3%	5%	7%	9%	12%
Viscosity (cp)	1,094±0.31^b	1,120±0.22^b	1,148±0.18^b	1,228±0.40^b	**1,274±0.11^b**	1,329±0.15^b
Sensory score	7.35±0.01^{cd}	7.41±0.02^c	7.85±0.03^{bc}	7.96±0.00^b	**8.27±0.01^a**	7.02±0.03^d

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 4. Effect of pasteurization

Pasteurization	80^{o}C, 60 s	85^{o}C, 50 s	90^{o}C, 40 s	95^{o}C, 30 s	100^{o}C, 20 s
Viscosity (cp)	1,294±0.17^a	1,290±0.21^{ab}	1,284±0.28^b	**1,280±0.12^{bc}**	1,274±0.11^c
Sensory score	6.13±0.01^c	7.45±0.01^b	8.01±0.01^{ab}	**8.44±0.01^a**	8.27±0.01^a
Coliform (cfu/g)	0	0	0	**0**	0

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 5. Effect of storage condition to stability of soursop juice

Parameters	Storage temperature (4^{o}C), week			Storage temperature (28^{o}C), week		
	0st	3rd	6th	0st	3rd	6th
Total soluble solid (^{o}Brix)	18.45 ±0.01^a	18.43 ±0.02^{ab}	18.40 ±0.00^b	18.45 ±0.01^a	18.30 ±0.01^{ab}	18.26 ±0.04^b
Titratable acidity (g citric acid/100 g)	1.41 ±0.02^a	1.38 ±0.01^{ab}	1.36 ±0.00^b	1.41 ±0.02^a	1.35 ±0.03^{ab}	1.31 ±0.01^b
pH	4.40 ±0.01^b	4.42 ±0.00^{ab}	4.43 ±0.04^a	4.40 ±0.01^b	4.43 ±0.00^{ab}	4.45 ±0.03^a
TPC (cfu/g)	1.1x10^1 ±0.01^b	1.2x10^1 ±0.03^{ab}	1.4x10^1 ±0.00^a	1.1x10^1 ±0.01^b	1.3x10^1 ±0.02^{ab}	1.7x10^1 ±0.01^a
Mold (cfu/g)	0	0	0	0	0	0
Coliform (cfu/g)	0	0	0	0	0	0

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

3.4 Effect of pasteurization

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water and sugar were added in 1:2 w/v and 9% respectively. Soursop juice was pasteurized in different condition (80^{o}C, 60 seconds; 85^{o}C, 50 seconds; 90^{o}C, 40 seconds; 95^{o}C, 30 seconds and 100^{o}C, 20 seconds). Viscosity, sensory, microbial measurements were applicated to demonstrate the optimal condition of pasteurization. From table 4, the optimal condition in pasteurization should be 95^{o}C, 30 seconds.

Nwachukwu et al., (2013) observed changes in the microbial population of pasteurized soursop juice treated with benzoate and lime during storage**.** The study revealed that the synergistic effect of pasteurization, acidification and treatment with sodium benzoate can be used to extend the shelf-life of soursop juice for up to two weeks.

3.5 Effect of storage condition to stability of soursop juice

The fruits were washed under running tap water, hand peeled, decored, deseeded and the pulp blended using an electric blender. The pulp was filtered using a muslin cloth. Water and sugar were added in 1:2 w/v and 9% respectively. Soursop juice was pasteurized in 95^{o}C, 30 seconds. Pasteurized soursop juice was store under refrigeration temperature (4°C) and ambient temperature (28°C) for 6 weeks. Samples were analysed for total soluble solid (^{o}Brix), titratable acidity (g citric acid/100 g), pH, aerobic mesophilic bacteria and moulds/yeasts counts and *coliform* counts at regular intervals of three week. From table 5, the soursop juice had a stable quality in ambient temperature during preservation.

Emmanuel S. Abbo et al., (2006) concluded that there were no counts in bacteria, moulds and yeasts and *coliforms* in the pasteurized juice, while low counts were observed in unpasteurized juice.

Storage stability of soursop (*Annona muricata* L.) juice at refrigeration (4°C) and ambient (28°C) temperatures was studied. Results showed that processing affects the physical and chemical composition of the soursop pulp. The soursop juice was found to be microbiologically safe for consumption. Results showed that the soluble solid of the pasteurized juice was more stable at 4°C than at 28°C. More acid was produced in the juice at higher temperature (28°C) than at lower temperature (4°C) during storage. Results have shown that pasteurisation of soursop juice reduced microbial counts from 3 x 10^5 to < 10x10^1 cfu/g for mesophilic aerobic counts and 27.5 x 10^6 to < 10 x 10^1 cfu/g for moulds and yeasts (Emmanuel S. Abbo et al., 2006)

IV. CONCLUSION

Soursop fruit juice is rich in nutrients such as amino acids, vitamins, fibre, proteins, unsaturated fats and essential minerals. The most frequent reason for quality deterioration of soursop juice is the result of microbial activity and this often result in food moulding, fermenting and change in acidity. Many consumers are concerned with the wholesomeness of products, which have undergone minimal heat treatment. Therefore the objective of this study was to determine the storage stability of soursop juice. We have successfully optimized various technical parameters influencing to production of soursop (*Annona muricata)* juice were clearly investigated such as ratio of pulp: water, sugar addition during the blending process; pasteurization, storage condition to stability of soursop juice.

REFERENCES

1. Abbo ES, Olurin TO, Odeyemi G (2006). Studies on the storage stability of soursop (*Annona muricata* L.) Juice. *African Journal of Biotechnology* 5: 1808-1812.
2. Ajayi AA, Peter-Albert CF and Adedeji OM (2015). Modification of cell wall degrading enzymes from soursop (*Annona muricata*) fruit deterioration for improved commercial development of clarified soursop juice (a review). *Medicinal & Aromatic Plants* 4(1): 1-5.
3. Amusa NA, Ashaye OA, Oladapo MO, Kafaru OO (2003). Preharvest deterioration of soursop (*Annona muricata*) at Ibadan South Western Nigeria and its effect on nutrient composition. *Afr. J. Biotechnol.* 2: 23-25.
4. AOAC (1984). Official Methods of Analysis, 14th Edition. Association of Official Analytical Chemists, Washington, DC, pp. 84-90.
5. Arif Kusumo Rahardjo, Moch Istiadjid Eddy Santoso (2016). Effect of soursop leaf and royal jelly on brain neuronal edema and apoptosis in rat cerebral contusion model mediated by bdnf/il-1β ratio. *Journal of Dental and Medical Sciences* 15(8): 1-11.
6. Banerjee A, Das D, Maji BK and Mukherjee S (2018). Anticancer effects of Annona muricata with its acetogenins as bioactive compound. *Cytology & Histology International Journal* 2(1): 1-6.
7. Egan H, Kirk RS, Sawyer R (1981). Pearson's Chemical Analysis of Foods, 8th Edition. Churchill Livingstone, Edinburgh, p. 124.

8. Eka Prasasti Nur Rachmani, Tuti Sri Suhesti, Retno Widiastuti Aditiyono (2012). The breast of anticancer from leaf extract of annona muricata againts cell line in T47D. *International Journal of Applied Science and Technology* 2(1): 157-164.
9. Elavarasan K., Govindhappa M., Soundararajan and Stephen Samuel D. (2014). Medicinal properties and uses of soursop (*Annona muricata* L.). *Rashtriyakrishi* 9(2): 73-75.
10. Emmanuel S. Abbo, Taiwo O. Olurin and Grace Odeyemi (2006). Studies on the storage stability of soursop (*Annona muricata* L.) juice. *African Journal of Biotechnology* 5 (19): 1808-1812.
11. Evy Sulistyoningrum, Eka Prasasti Nur Rachmani, Hanif Nasiatul Baroroh, Lantip Rujito (2017). *Annona muricata* leaves extract reduce proliferative indexes and improve histological changes in rat's breast cancer. *Journal of Applied Pharmaceutical Science* 7(01): 149-155.
12. Islam Rady, Melissa B. Bloch, Roxane-Cherille N. Chamcheu, Sergette Banang Mbeumi, Md Rafi Anwar, Hadir Mohamed, Abiola S. Babatunde, Jules-Roger Kuiate, Felicite K. Noubissi, Khalid A. El Sayed, G. Kerr Whitfield, and Jean Christopher Chamcheu (2018). *Oxidative Medicine and Cellular Longevity* Volume 2018, Article ID 1826170, 39 pages.
13. Khairun Nisa Berawi, Liana Shidarti, Samsu U. Nurdin, Nur Indrawati Lipoeto, Irza Wahid, Jamsari and Endang Nurcahyani (2017). Comparison effectiveness of antidiabetic activity extract herbal mixture of soursop leaves *(Annona Muricata)*, bay leaves *(Syzygium Polyanthum)* and pegagan leaves *(Centella Asiatica)*. *Biomedical & Pharmacology Journal* 10(3): 1481-1488
14. Kumar S, Venkatarathanamma, Saibabu N, Ram S (2015). Antipyretic activity of annona plants leaves on brewer's yeast induced febrile rats. *Asian J Pharm Clin Res* 8:210-12.
15. Lili Indrawati, Suwijiyo Pramono, Purwantyastuti Ascobat, Budiman Bela, Murdani Abdullah, Ingrid S. Surono (2017). Cytotoxic activity of soursop "*Annona muricata*" leaves extracts and their phytochemical contents. *Journal of Global Pharma Technology* 02(9): 35-40.
16. Mithun Pai B.H., Gururagavendra Rajesh, Ramya Shenoy, and Ashwini Rao (2016). Anti-microbial efficacy of soursop leaf extract (*annona muricata*) on oral pathogens: an in-vitro study. *J Clin Diagn Res*. 10(11): 1–4.
17. Nguyen Phuoc Minh (2017). Production of Formulated Juice Beverage from Soursop and Grapefruit. *International Journal of Applied Engineering Research* 12(24): 15311-15315.
18. Nwachukwu E, Ezeigbo CG (2013). Changes in the microbial population of pasteurized soursop juice treated with benzoate and lime during storage. *Africa Jounal of Microbiology Research* 7: 3992-3995.
19. Prasetyorini Djarot, Moerfiah Badar (2016). Formulation and production of granule from annona muricata fruit juice as antihypertensive instant drink. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(5): 18-22.
20. Puran Bridgemohan, Aphzal Mohammed, and Ronell S. H. Bridgemohan (2015). Caribbean soursop (*Annona muricata*) varieties II: Annonaceous acetogenin properties. *International Journal of Phytocosmetics and Natural Ingredients* 2: 1-17
21. René G. Degnon, Euloge S. Adjou, Jean-Pierre Noudogbessi, Grâce Metome, Fortuné Boko, Edwige Dahouenon-Ahoussi, Mohamed Soumanou, Dominique C.K. Sohounhloue (2013). Investigation on nutritional potential of soursop (Annona muricata L.) from Benin for its use as food supplement against protein-energy deficiency. *International Journal of Biosciences* 3(6): 1-10.
22. Sejal Patel, Jayvadan K Patel (2016). A review on a miracle fruits of *Annona muricata.Journal of Pharmacognosy and Phytochemistry* 5(1): 137-148.
23. Umme A, Bambang SS, Salmah Y, Jamilah B (2001). Effect of pasteurisation on sensory quality of natural soursop puree under different storage conditions. *Food Chem.* 75: 293-301.
24. Uno UU, Ogbe HO, Okolo CM, Ekaluo UB, Akwa BU (2017). Effect of soursop (*Annona muricata* L.) Leaf extract on sperm toxicity induced by caffeine in albino rats. *The Pharmaceutical and Chemical Journal* 4(1): 82-87.