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Impact of clarification process on the nutritional, mineral and vitamin composition of cashew (*Anacardium occidentale*) apple juice

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This study investigates the impact of clarification process on the nutritional, mineral and vitamin composition of the cashew apple juice. The proximate composition in percentage for moisture, dry matter, ash, crude fibre, ether extract, crude protein and carbohydrate were determined in line with the recommended methods of Association of Official Analytical Chemist (AOAC), and vitamin profile was analysed using Gas Chromatography coupled with the Pulsed Flame Photometric Detector (GC-FPD). The mineral analysis also followed the recommendation of AOAC. The clarified cashew apple juice had values in mg/100 of 10.1, 6.1, 2.2, 28.8, 10.2 and 0.22 for calcium, magnesium, sodium, potassium, phosphorus and iron, respectively. The study showed that cashew apple juice is rich in nutrient and contains a good level of trace elements necessary for healthy living. Rice gruel as a natural sourced clarifying agent can better replace industrial clarification agents for a safer drink production.

Key words: Clarification process, nutritional composition, mineral composition, vitamin composition, cashew apple juice.

INTRODUCTION

Nutrients are chemical constituents' in food that are required by living organisms to keep them alive and active. Nutrients are present in food as large molecules which have to be broken down into tiny particles before it can be used by the living organisms. Good nutrition according to S´anchez-Moreno et al. (2006) means getting adequate amount of nutrients from healthy foods such as fruits, vegetables among others in appropriate combination. Fruits have been found to contain essential nutrient such as vitamins, minerals, fibres and phytochemicals which make them essential for a balance diet (Anu and Rajinder, 2006). Consumption of fruits and vegetables contributes to good health and well being of man. Many people prefer fruits due to the fact that they believed it is a source of diet with low fats and sodium content. Consumption of fruit everyday have been reported to reduce by halve the risk of developing cancer and also the risk of cardiovascular diseases, diabetes,

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stroke, obesity, birth defects, cataract, osteoporosis among others (Anu and Rajinder, 2006). Due to high cost and/or unavailability of food substance containing the essential classes of food and other needed nutrients, there is need to search for other alternative sources of nutrients using fruits juices. Fruits are highly perishable and seasonal in nature and during glut season, a lot of fruits are wasted due to lack of the knowhow by farmers in the processing of the fruit to make the product available during off season. Cashew apple is one of such fruits discovered to have rich essential vitamins, minerals, fibre and other phytochemicals that can be processed into juice (Ashok and Upadhyaya, 2012). However, the juice from cashew apples contain tannins which give the raw juice an astringent taste and dry mouth feeling when consumed (Odurole et al., 2001; Ashok and Upadhyaya, 2012). To make the juice attractive, the tannins which give it the undesirable taste need to be removed through clarification. Clarification is a process by which the semi-stable emulsion of colloidal plant carbohydrates that support the insoluble cloud material of a freshly pressed juice is “broken” such that the viscosity is dropped and the opacity of the cloudy juice is changed to an open splotchy look (Sharma et al., 2015). Clarification is an important step in the processing of fruit juice mainly in order to remove pectin and other carbohydrates which are present in the juice. Rice gruel can be used for clarification on the assumption that fruit juice on the addition of clarifying agents such as rice gruel or gelatin, the colloids present in the juice coagulate and form a flocculent precipitate which settles down. The precipitation is due to the electrostatic attraction between the positively charged rice gruel particles and the negatively charged colloids in the juice. Generally, clarifying procedures can be achieved by centrifugation, enzymatic treatment or non-enzymatically by applying heat and use of clarifying agents such as gelatine, bentonite, silica sol, and polyvinyl pyrrolidone (Chatterjee et al., 2004). Clarification processes of fruit juice may have significant influence on the nutritional, mineral and vitamin composition of the juice. At times, essential nutrients in fruits and vegetables are often damaged or transformed during clarification. Tiwari and Cummins (2013) and Tiwari et al. (2009) reported that conventional thermal, non-thermal, domestic and industrial processing widely degrade the levels of phytochemicals in processed food. Food processing according to Tiwari et al. (2013) changes the nutritional properties of some foods for instance, partial hydrogenation of vegetable oil results in the formation of trans-fatty acid and heat treatment of protein solutions in an alkali environment results in the formation of lysinoalanine. On the other hand, some nutrients and bioactive compounds that are naturally present in fruits may undergo transformations during food processing that neither decrease their nutritional value nor bioactive value but may increase it by favouring their absorption and metabolism in the human body (S´anchez-Moreno et al., 2006). Available literature revealed that most of the industrial clarification of fruit juice is carried out using gelatin of which there is some concern about the safety of gelatin because it comes from animal sources, some of these animals such as cow may be suffering from mad cow disease (bovine spongiform encephalopathy) and as a result may go along to pose health challenges on the consumers. Therefore, safer and cost effective bio-process clarification of fruit juice using natural products of plant origin such as rice gruel is necessary. This study therefore focused on determining the impact of clarification process on the nutritional, mineral and vitamin composition of cashew (*Anacardium occidentale*) apple juice using rice gruel. Cashew apple is that part of the fruits which is eaten fresh. The apple constitutes the major parts of the fruit representing 90% of its weight. It is consumed in fresh state and has rich flavor, aroma and vitamin C content higher than that of orange, mango and guava juices (Soares et al., 2007). The juice has to be processed and preserved to keep it available all year round.

MATERIALS AND METHODS

The plant materials used for the experiment were fresh ripped cashew apples obtained from Ochaja cashew plantation farm, Kogi State, Nigeria and polished rice also obtained from Kogi State (7.49°N and 6.45°E), a locality of high cashew tree plantation in Nigeria. The fresh ripped cashew apples were transported under refrigeration conditions to agricultural laboratory of the department of agricultural and bio-resources education, University of Nigeria, Nsukka. The study adopted experimental design and spanned from November, 2016 to March, 2017. It covered clarification of cashew juice using rice gruel as clarifying agent, nutritional, mineral and vitamin analysis were also carried out.

Preparation of clarifying agent (rice gruel)

Six glass of water was measured into a pot and brought to boil. One cup of parboiled rice was measured, washed and poured into the boiled water, mixed well and the pot covered and kept on a low heat. The rice was cooked on a low heat between 20 and 25 min. The pot was removed from heat and the rice with the water poured into a sieve to get the water referred to as rice gruel. The rice gruel was then allowed to cool down and was filtered using a muslin cloth. The filtrate was kept in a container for clarification.

Juice extraction

The collected cashew apples transported to the laboratory had their nuts detached. The apples were washed thoroughly using distilled water. The apples were then cut into slices and the juice obtained by pressing the mash through a muslin cloth. The obtained juices were then separated into two different containers for the clarification assay and sample analysis.

Experimental clarification of the cashew apple juice

The clarification process of the cashew apple juice using rice gruel was carried out in line with the recommendation of Cormier (2008).

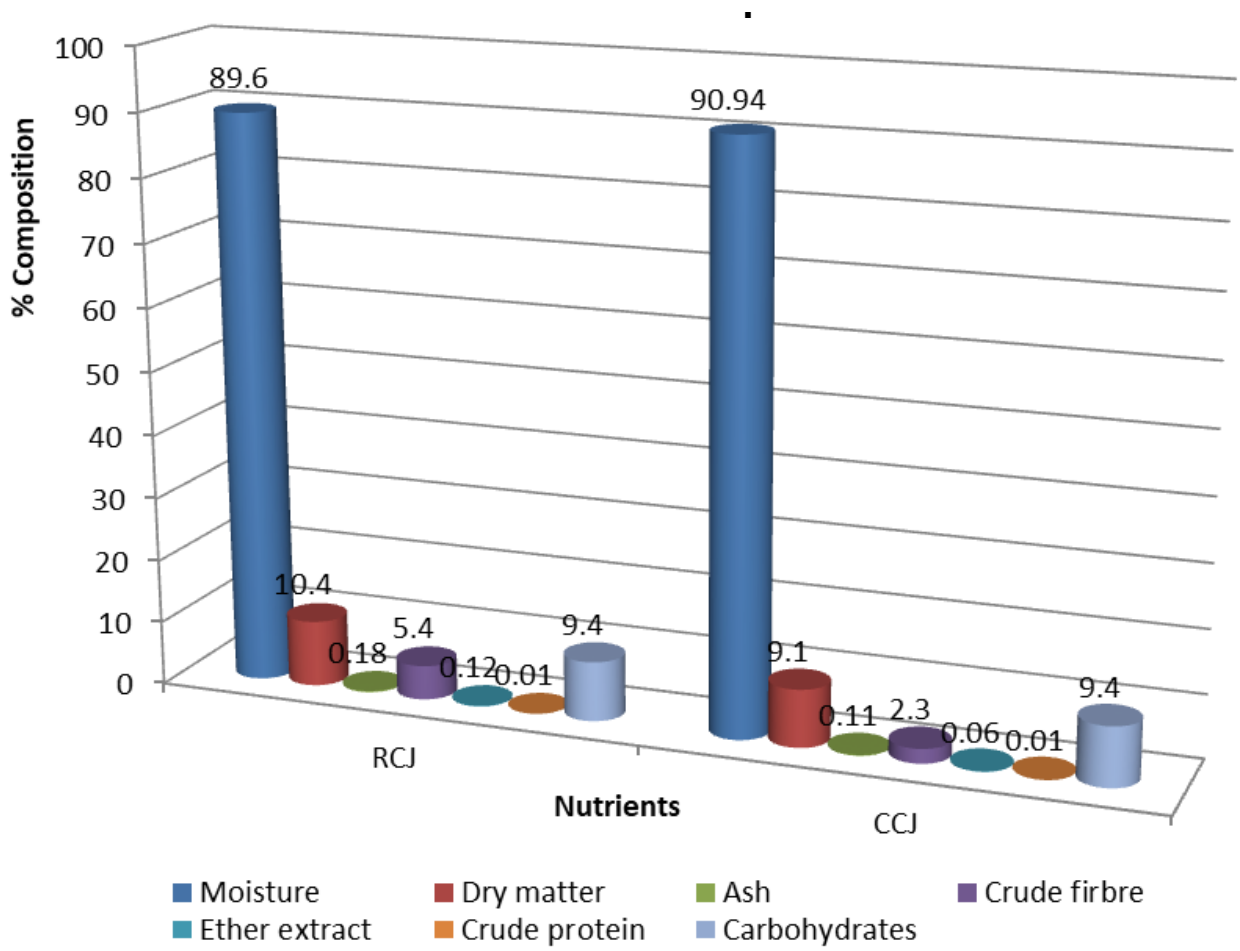

Figure 1. Histographic representation of the result of the proximate analysis carried out on cashew apple juices. RCJ, Raw cashew juice; CCJ, clarified cashew juice.

With 1 L of the raw juice in a stainless steel vessel, the juice was stirred in a circular motion and 125 mL of rice gruel was slowly poured into the juice and was constantly stirred for 5 min to ensured thorough blend of juice and solution. The juice was allowed to rest until the tannins settled at the bottom of the vessel. At this point, the vessel was covered. The cleared juice was siphoned using rubber turbines into a cleaned plastic container and labelled sample B. The raw juice in the other plastic container was labelled sample A.

Data collection

The data for the study was obtained through laboratory analysis of cashew juice samples. Both samples labelled as Raw Cashew Juice (RCJ) sample A and Clarified Cashew Juice (CCJ) sample B were analyzed for physical and chemical properties in line with the recommended methods of Association of Official Analytical Chemist (AOAC, 1984).

Analysis of sample

Analysis of moisture, ash, protein and crude fat were carried out using the recommended methods of the AOAC (1984). Vitamin profiles were analyzed using Gas Chromatography coupled with the Pulsed Flame Photometric Detector (GC-FPD) methods. The mineral analysis also followed the recommendation of AOAC (1984).

RESULTS

The result in Figure 1 reveals the percentage composition of raw cashew juice as follows in (%): moisture 89.60, dry matter 10.40, ash 0.18, crude fibre 5.40, ether extract 0.12, crude protein <0.01 and carbohydrates 9.40. The clarified cashew juice had 90.94, 9.10, 0.11, 2.30, 0.06, <0.01 and 9.40 for moisture, dry matter, ash, crude fibre, ether extract, crude protein and carbohydrate, respectively

The result in Figure 2 shows mineral analysis of raw and clarified juice in mg/100. The raw juice in mg/100 revealed 10.2 for calcium, 6.2 for magnesium, 10.8 for sodium, 28.7 for potassium, 5.1 for phosphorus and 0.22 for iron. The clarified juice indicated 10.1 for calcium, 6.1 for magnesium, 2.2 for sodium, 28.8 for potassium, 10.2 for phosphorus and 0.22 for iron, respectively.

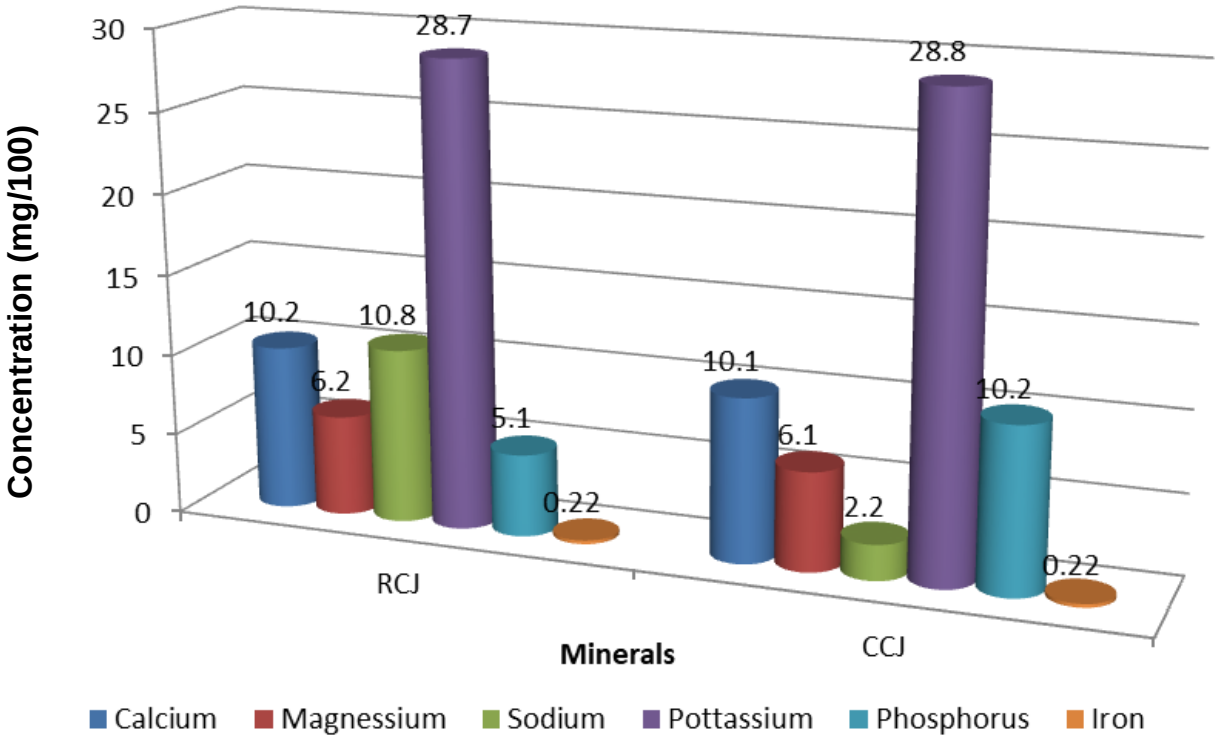

Figure 2. Histographic representations of results of the mineral composition carried out on the cashew apple juices. RCJ, Raw cashew juice; CCJ, clarified cashew juice.

Table 1. Vitamin composition of the raw and clarified cashew juices.

Vitamin	Retention time (min)	RCJ [pA.s]	Retention time (min)	CCJ [pA.s]
A	17.10	189.10	17.10	110.93
B1	18.10	314.10	18.10	230.07
B2	18.84	179.81	18.84	130.38
B3	12.27	16.70	12.27	12.15
B5	22.61	277.61	22.61	217.29
B6	13.74	112.70	13.74	78.23
B9	20.54	94.95	20.54	70.31
C	16.04	153.24	16.04	109.41
D	19.24	105.71	19.24	77.35
E	19.52	297.94	19.52	217.37
K	21.82	156.73	21.82	165.42

RCJ, Raw cashew juice; CCJ, clarified cashew juice; pA.s, picoAmpseconds

The result in Table 1 reveals the vitamin profiles per area and the retention time of both raw and clarified cashew apples juice. Vitamin composition for the raw cashew apple revealed the following results in (pA.s): vitamin B_3=16.70, vitamin B_6= 12.70, vitamin C=153.24, vitamin A=189.10, and vitamin B_1= 314.10, respectively, whereas the clarified cashew apple juice had the values of 12.15, 78.23, 109.41, 110.93, and 230.10 pA.s for vitamin B_3, B_6, C, A and B_1, respectively.

DISCUSSION

The result of proximate analysis revealed that there was a ($P<0.05$) significant difference in the moisture contents between the raw and clarified forms of cashew juice. A

significant (P<0.05) decrease in dry matter was observed when clarified. This indicated that processing decreases the dry matter of cashew juice. This is however not a good development since the presence of moisture or high range of moisture in food makes it spoil faster indicating decrease in the shelf life of the food. A non-significant (P>0.05) decrease in ash content was observed when cashew juice was clarified. Ash is a non-organic compound containing mineral compound of food and nutritionally it aids in the metabolism of other organic compounds such as fat and carbohydrate (Okonkwo and Ozoude, 2015). The observed decrease in ash content on processing was not significant (P>0.05) and therefore of no major concern. It was also observed that there was no significant (P<0.05) change in crude protein when the cashew juice was clarified. Protein is very important for the repair of worn out tissues in the body, promotes growth and organ development. The carbohydrate content of the cashew juice was not altered, an indication that clarification of cashew juice using rice gruel neither decreased nor increased the carbohydrates. Cashew juice have moderate concentration of carbohydrate and are therefore an energy food implying that the consumption of cashew juice by young and old gives enough energy to carry out specific metabolic functions (Giwa and Abiodun, 2010).

The result of the proximate analysis carried out on cashew juices in the raw and clarified form also showed that there was a significant change in some parameters tested for except for carbohydrates, crude protein, and dry matter which showed no significant (P>0.05) difference. Crude fiber is known to aid digestion in humans. Ihekoronye and Ngoddy (1985) indicated that food or diet low in fiber content is undesirable and can cause constipation and such diets have been associated with diseases of colon like piles, appendicitis and cancer (Okonkwo and Ozoude, 2015). There was significant decrease in ether extract composition on clarification of the cashew juice. This decrease is a good development since rancidity that promotes the development of unpleasant and odorous compounds is low. Diets too high in fats predispose consumers to different illness such as obesity, coronary heart disease (Okpala and Chinyelu, 2011) and are therefore not desirable.

There was a significant (P<0.05) difference in mineral composition between the raw and the clarified cashew juices. The results show that clarification increased some of the minerals tested for in cashew juices significantly (P<0.05), while there was no significant change for some minerals such as calcium and magnesium except for sodium where there was a significant (P<0.05) decrease after clarification. It may therefore be advised that cashew juice be taken in its clarified form. Calcium is essential for the normal development of the body. It is an important constituent of bones and teeth. It is also essential for many metabolic processes including nerve function, muscle contraction and blood clothing. A deficiency of calcium in the body leads to conditions such as rickets, osteomalacia, and osteoporosis. A deficiency of calcium in the blood may lead to tetany. The presence of calcium in trace amount is very necessary and can alleviate nutritional impairments such as rickets (Okonkwo and Ozoude, 2015). Magnesium just like calcium is important for proper functioning of muscle and nervous tissues. It is required as a cofactor for many enzymes in the body. Phosphorus just like calcium is important in bone formation, metabolism and in energy conversion and storage in the body. Sodium and potassium are important for nerve transmission and osmolarity while iron is an essential component in the transport of oxygen in the body. A deficiency of iron will lead to anaemia. Therefore, adequate intake of potassium and iron is necessary for a healthy life (Okonkwo and Ozoude, 2015).

Table 1 shows that there was a significant (P>0.05) decrease in all the vitamins present in cashew juice after clarification except for vitamin K which increase significantly (P<0.05) from 156.73 to 165.42 pA.s on clarification. The result revealed that clarification has impact on the vitamin content of cashew juice. However, it is noted that clarified juice contained considerable amount of vitamin which makes it suitable for consumption. The importance of vitamin in diet cannot be neglected. Vitamin B_1, B_2, B_3 and B_6 (thiamin, riboflavin, niacin and pyridoxine) serve as coenzymes in all part of the body, they take part in protein, carbohydrates and fat metabolism, they are also important in the structure and function of the nervous system (IM, 1998; ASNS, 2004; Lukaski, 2004). Vitamin C is essential in maintaining healthy connective tissues, cell wall integrity, collagen synthesis and prevention of scurvy (S´anchez-Moreno et al., 2003). Vitamin A like other vitamins is essential for growth, vision and maintenance of soft mucous tissues (Okonkwo and Ozoude, 2015). Vitamin E is useful in reducing the risk of developing degenerative disease (Bramley et al., 2000; S´anchez-Moreno et al., 2003). The appreciable increase of vitamin K as shown in Table 1 is a welcome development; this is due to the importance of vitamin K in blood clothing as well as its function in the inhibition of the growth of certain types of cancer including those of liver and gut tumour (Martins and Paul, 2008).

Cashew juices have appreciable amounts of vitamins, minerals and nutrients. The ascorbic acid content also indicates that cashew juices in clarified form can be used to prevent or at least minimize the formation of carcinogenic substances from dietary materials (Okonkwo and Ozoude, 2015). The presence of carbohydrates, fat and protein also make it a good source of energy. The present research with rice gruel for cashew juice clarification shows that clarification has impact on the proximate composition of the clarified juice. The study revealed that some nutrients such as crude fiber, ether extract and ash have been decreased as a

result of clarifications. The study showed that carbohydrates and crude protein remain unchanged while moisture content increased after clarification. The study also revealed that no major changes occurred in the mineral composition of the clarified juice when compared with the raw juice except for sodium which decreased upon clarification. Clarification increased the phosphorus composition from 5.1 to 10.2 mg upon clarification. The study further showed a negligible decrease in all vitamin composition of the clarified juice except for vitamin K which increased from 156.73 to 65.42 pA.s. Cashew juice has good amount of vitamins, minerals and nutrient. And its high ascorbic acid (Vitamin C) indicates its usefulness as anti-carcinogenic substances.

CONCLUSION AND RECOMMENDATION

The study conducted confirms the effectiveness of rice gruel as a clarifying agent for the removal of tannins content of cashew juice which makes it more desirable for consumption. The clarified juice was not significantly affected in terms of the proximate, mineral and vitamin composition. The rice gruel used in this study showed that it is an efficient and economic natural product for the clarification of cashew apple juice. Information on the utilization of rice gruel for cashew apple juice clarification should be made available for farmers in order to help them have access to a cheaper and natural agent of clarification.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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