

PROJECT REPORT

CASHEW FRUIT - ADDING VALUE FOR FOOD SECURITY

PROJECT IMPLEMENTATION PERIOD
November 2014 – June 2017

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SUMMARY

The project sought to develop highly nutritious food products from cashew fruits which would be accepted by consumers. To achieve this aim, two methods, using Gelatin or High Quality Cassava Flour (HQCF) were used to reduce tannin levels in the fruit. HQCF reduced tannin by 69.5% while Gelatin reduced tannin by 57.7%. Three products (cashew apple-enriched cereal, dried cashew apple snack, cashew apple juice) were developed from cashew fruits and assessed for nutritional and microbial properties as well as consumer acceptability. The products were all within acceptable microbial limits (aerobic plate count, coliforms, yeasts and moulds, E. coli) set by the Ghana Standards Authority after formulation and after storage for 6 months. The dried cashew apple snack contained about 700% more of Vitamin C as compared to the same weight of fresh fruit. The cashew-enriched cereal containing sugar and gelatin-treated fruits was the most accepted product formulated. This was followed by Gelatin-treated 100°C for 3 minutes pasteurized cashew juice. The least accepted cashew apple product was the Gelatin-treated dried cashew fruits. 19.2% solids, using maltodextrin as the carrying agent was found as the ideal lower limit for juice dehydration by spray drying. Several stakeholders like farmers, entrepreneurs and government representatives were educated on the potential of cashew fruits as a source of income for farmers and alternative food source for Vitamin C.

INTRODUCTION

In a bid to increase the agricultural revenue base of the country, the Government of Ghana has over the years been adding new crops to the list of crops (trees and food) that generate money into the national coffers. Cashew (*Anacardium Occidentale*) is one of such crops of interest in Ghana's agricultural revenue stream. Today, the crop is regarded as one of the most important tropical cash crops, grown mainly for its nuts (ACI, 2013) and now for the preparation of juices, alcohol and others such as wine and pulp produced from cashew apple or pseudo-fruit. In Ghana, cashew nuts have been recorded as a high economic-earner export commodity, with about 196 million USD worth of cashew being exported in 2016 alone (GEPA, 2017). Despite this huge figure, it represents almost 20% decrease from the quantity exported in 2015 (GEPA, 2017). Eventhough Cashew is reported to have originated from Brazil, Brazil now holds only 4% of the total cashew production and west Africa holds 45% with Ivory Coast being the largest producer in the sub region and the second largest in the world (Rabany et al., 2015). In Ghana, cashew thrives in several agro-ecological zones but, there is a high concentration of the crop in the middle belt areas, specifically the Brong Ahafo Region of Ghana. Typical cashew communities include Techiman, Wenchi and Sampa. Approximately 40,000 farmers are engaged in cashew cultivation with about 90% of them being smallholder farmers (ACI, 2013). It is projected that the total surface of cashew production areas cover an area of 9m Ha with an average raw cashew nut yield of 296kg/ha (ACI, 2013). Although the crop is drought resistant, it requires an annual precipitation range of 500-4000 mm and a clear four-month period, free from rainfall to get high yields (Dedzoe et al., 2001).

The cashew nut is part of a whole fruit including a fleshy apple which is attached to the stalk of its tree. Observation shows that in many of the cashew farms in the country, a lot of the fleshy apples are left to go waste, as a result of the less economic value people place on the fruit. In addition, the fruit has a very delicate skin which makes it highly perishable and unstable for transportation. The loss of revenue from such sources through the inability of economic players to add value to the apple and nuts limits the potential of the crop as a foreign exchange earner, source of employment and income as well as food in the form of value added cashew products.

With economic empowerment of farmers in mind, this study aimed at transforming Ghana's cashew fruit sector from a no-priced commodity to an exporter of high quality cashew apple products in the near future. It specifically explores the consumer acceptability of value-added cashew fruit products as well as the level of awareness of farmers in the economic and food-product potentials of cashew, particularly the fresh fruit.

PROFILE OF CASHEW FARMING ACTIVITIES IN TARGETED DISTRICTS

An exploratory and qualitative study was conducted in four (4) districts, including the Wenchi, Berekum East, Kintampo North and Jaman North districts. The survey involved a total of 201 respondents made up of a varied group with different genders, ages and farm sizes. 74.1% of total respondents were males, indicating their dominance in cashew farming in the study area. 29.0% had no form of formal education while only 7.5 % had tertiary education. 63.7%, representing the majority were between ages 34 and 60, followed by

28.9% being above 60 years and 7.5% falling between the 18 to 33 age brackets. Figure 1 depicts the number of years the respondents have been engaging in farming activities.

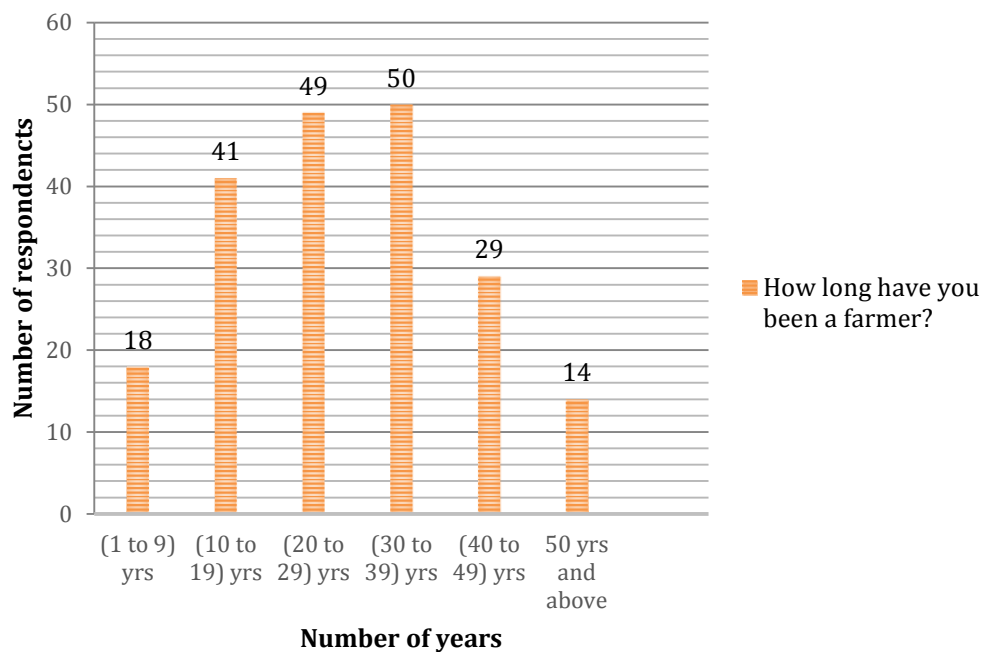


Figure 1: Number of years respondents have been in farming
The majority of respondents have been in farming for between 30 and 39 years.

93% of the respondents indicated that they were the primary source of labour for their respective farms as they worked on the farms themselves. In addition, almost 60% affirmed that they used family as a source of labour while 84.6% affirmed the use of hired labour. Figure 2 describes the labour categories who are involved in specific farm activities.

Labour Categories Employed for Specific Farm Activities

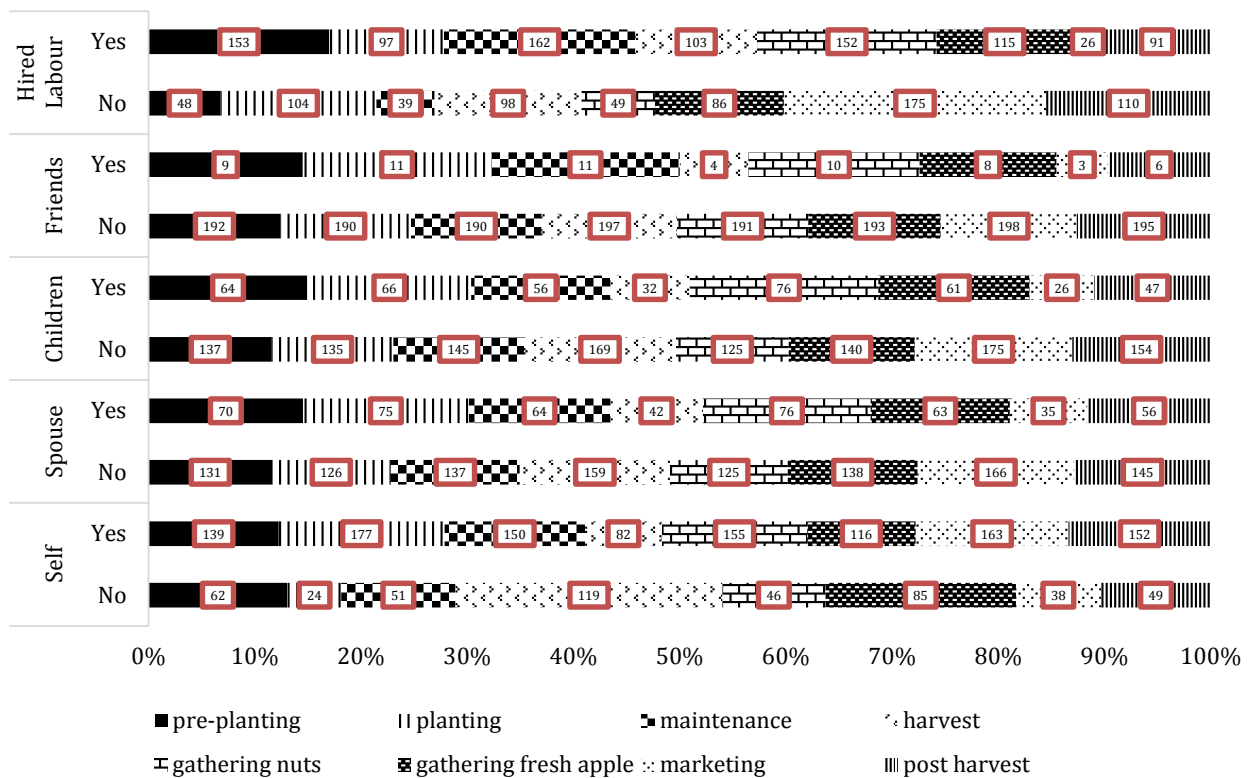


Figure 2: Labour categories used for various farming activities

From figure 2, it can be observed that majority of the farmers use hired labour for pre-planting activities whiles planting activities are mostly done by friends of the farmers. This pre-supposes that farmers assist each other during planting. Furthermore, majority of farmers use hired labour to maintain the farm as well as for harvesting but the gathering of nuts and marketing are done by most farmers themselves. Although it was not easy to differentiate between which activity was mostly carried out by which category of the social actors, a few activities were distinguished. For example, the statistics indicate that pre-planting activities was mostly carried out by hired labour, friends, spouses and/or children. It was found out that while self labour was frequently used for planting, it was less frequently used for harvesting. Gathering of fresh fruits was another activity that involved almost all of the various categories of labour identified. Generally, the results show that there was no clear cut farm activity assigned mostly to a particular social group or labour force and that everyone was involved in almost all the different types of activities. In the case of financing farm activities for increased productivity, 91.5% of total respondents stated that they had no access to credit facilities. The entire respondents did not sell any of the harvested cashew apples. This shows that the apples were of no significant economic importance to them. Their prime concern was the nuts, which really had a huge economic strength in the study area. However, some respondents indicated that they consumed the cashew apples in various frequencies (Figure 3)

FREQUENCY OF CASHEW APPLE CONSUMPTION

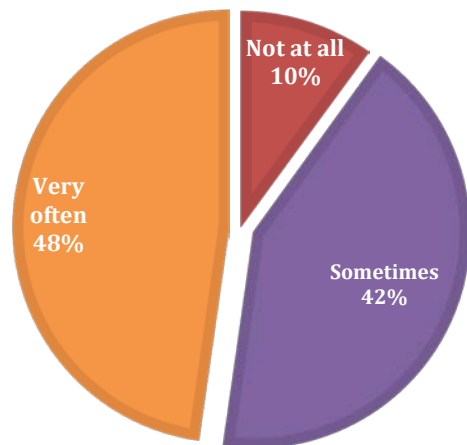


Figure 3: Frequency of consumption of cashew apples by farmers

There was a relatively narrow gap between those who ate it very often and those who ate it sometimes. It is a notion that cashew apple is unhealthy because it contains certain chemicals which are not good for human health. When farmers were asked if this was a reason that deterred them from eating the apples, 81.8% disagreed whereas 9.6% agreed and 8.6% were unsure.

77.5% of the farmers stated that they prefer cashew juice to eating the fresh apples since it was more attractive. However, 14.3% disagreed with this and 8.2% were unsure. This gives good grounds for prospecting into cashew fruits being processed into juice and other value added products to make it more attractive for consumption. This will result in market for the apples which currently are of no use to the farmers.

METHODOLOGY

The process begun with a SWOT analysis of the cashew fruit product sector based on the socio-economic survey done with 201 farmers. It further continued with an analysis of requirements for production of cashew apple-based foods. Subsequently, new products were formulated which are outlined in the following sections.

SWOT ANALYSIS OF CASHEW FRUIT PRODUCTS

Table 1 gives a presentation of a SWOT analysis for the cashew fruit processing industry

TABLE 1: A SWOT ANALYSIS OF THE CASHEW FRUIT PROCESSING INDUSTRY IN GHANA

STRENGTHS	WEAKNESSES
High nutritional value of fruits	Short shelf life of fresh fruit
High fruit output in peak season	Inadequate financial support for farming activities
Strong Farmer group associations	Capital intensive investment
Government current commitment and support to agricultural productivity	
OPPORTUNITIES	THREATS

Available research and development expert support	Bad perception of fruit properties by consumers
Increase in fruit consumption	Short fruit production season
Ability to be transformed into various value added products	Availability of similar and competitive products on various markets
Consumption of cashew apple products in neighbouring countries	Competition by established industries in other countries like Brazil and Ivory Coast
Development of local market for cashew value added products	No established harvesting mechanisms for the cashew fruits
Low management requirements of Cashew plantations	
Creation of jobs and wealth through value addition to the cashew fruits	

PRODUCTION OF CASHEW APPLE PRODUCTS

REQUIREMENTS

Capital: This includes infrastructure and equipment. The location of the processing site is critical as the further away it is from production sites, the more expensive the final product will be due to the cost of transportation and the loss of fruits as a result of deterioration during transit.

Labour: People who are skilled and knowledgeable in fruit processing, equipment maintenance, marketing, finance management and company management will be required for smooth operations, high quality cashew fruit product outputs and marketing of products.

Raw materials: The adequate supply of raw materials as well as their storage for lean periods is critical. Other consumables required for processing should also be available for production processes.

Utilities: These include liquified petroleum gas (LPG), electricity (from national grid or alternative like solar energy), water (from national water suppliers or alternative like boreholes with reverse osmosis mechanisms)

DRIED CASHEW APPLE

Cashew Apple Preparation

Cashew Apples were washed and weighed with the nut (55.787 kg)

Apples were then weighed without the nut (50.715 kg)

Weight of chopped fruits (48.3kg)

This was split into 3 for various treatments and control

Tannin reduction treatment

One group was Treated with 4g of 20% High Quality Cassava Flour (HQCF) per 1kg chopped fruit, left to stand for 1 hr and drained.

The second group was Treated with 2.5g of 10% Gelatin solution per 1kg chopped fruit, left to stand for 1hr and drained.

The third group remained the same as control group.

Juice was squeezed out of each group of cashew fruit in preparation for drying.

The fruits were dried at 60°C for 8hrs to a water activity of 12. The processes are outlined in figure 4.

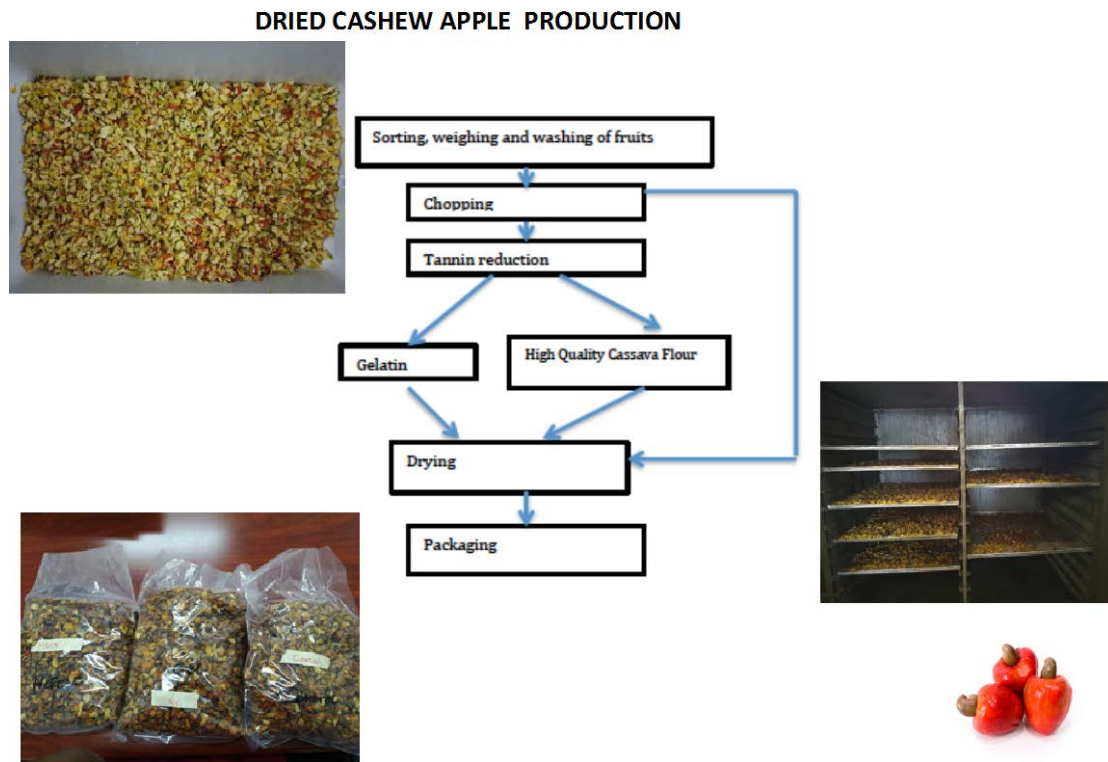


Figure 4: Dried cashew apple preparation

Cashew apple enriched ready-to-eat cereal formulation

Maize was blanched for 30mins and dried at 170°C for 4hrs. The dried maize was then milled.

Soybean was blanched for 3 mins and dried at 170°C for 4hrs. It was then milled

Groundnut was blanched for 30 mins. It was dehulled and roasted at 60°C for 30mins

Ingredients for Formulation (Sugar Sweetened)

400g maize/soybean/groundnut mix

½ Tsp salt

150g Sugar

1Tsp oil

Ingredients for Formulation (Honey Sweetened)

400g maize/soybean/groundnut mix

½ Tsp salt

150g Honey

1Tsp oil

All ingredients were weighed into a mixing bowl (based on the type of sweetener) and mixed thoroughly until a smooth and consistent mixture was obtained. The oven was preheated to 140°C for 10mins. The mixture was spread thinly on an aluminium tray and roasted in the oven for 40mins at 140°C with 10 min stirring intervals. For each kilogram of this mixture, 50g of chopped and dried cashew fruits was added and mixed thoroughly. Consumer acceptability test was carried out by 50 non-trained panelists who ranked each product on appearance, taste, colour, aroma, texture, mouthfeel and overall acceptability. Nutritional and chemical analysis were done for the cereal mix using standard methods.

Figure 5 depicts the flow diagram for cashew apple enriched ready-to-eat cereal formulation.

CASHEW APPLE-ENRICHED CEREAL FORMULATION

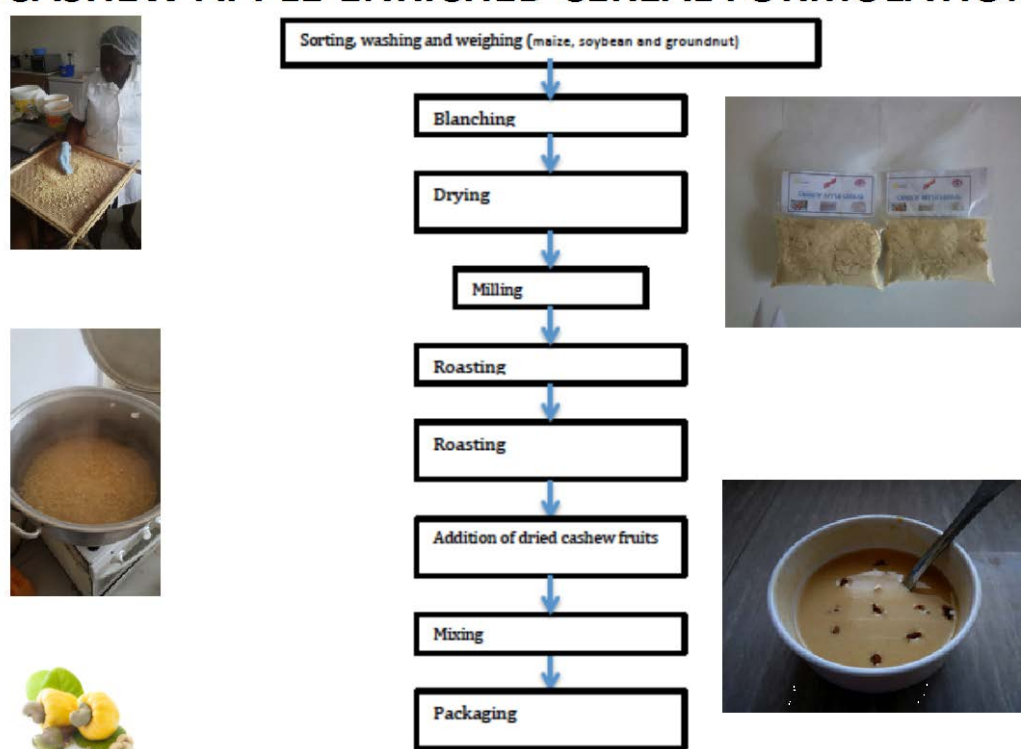


Figure 5: Cashew apple enriched ready-to-eat cereal preparation

CASHEW APPLE JUICE

Cashew Apple Preparation

Cashew Apples were washed and weighed with the nut (56.295 kg)

Apples were then weighed without the nut (51.013 kg)

Apples were juiced with Yamto fruit juicer. For the 51.013kg apples a volume of 41L of juice was obtained. The juice was split into 3 for various treatments and control.

Tannin reduction treatment

One group was Treated with 4g of 20% High Quality Cassava Flour (HQCF) per 1L of juice, left to stand for 1hr and decanted.

The second group was Treated with 2.5g of 10% Gelatin solution per 1L of juice, left to stand for 1hr and decanted.

The third group remained the same as control group.

The juice was Pasteurised at 70°C for 3mins or 100°C for 3 mins each. Microbial analysis (Aerobic Plate Count, E. coli, Coliforms, Yeasts and Moulds) were conducted on the samples and over a period of 6 months for shelf life. Nutritional analysis (Protein, Vitamin C, Tannins, Sugars) were also conducted on the samples

Figure 6 depicts a flow diagram for cashew apple juice preparation

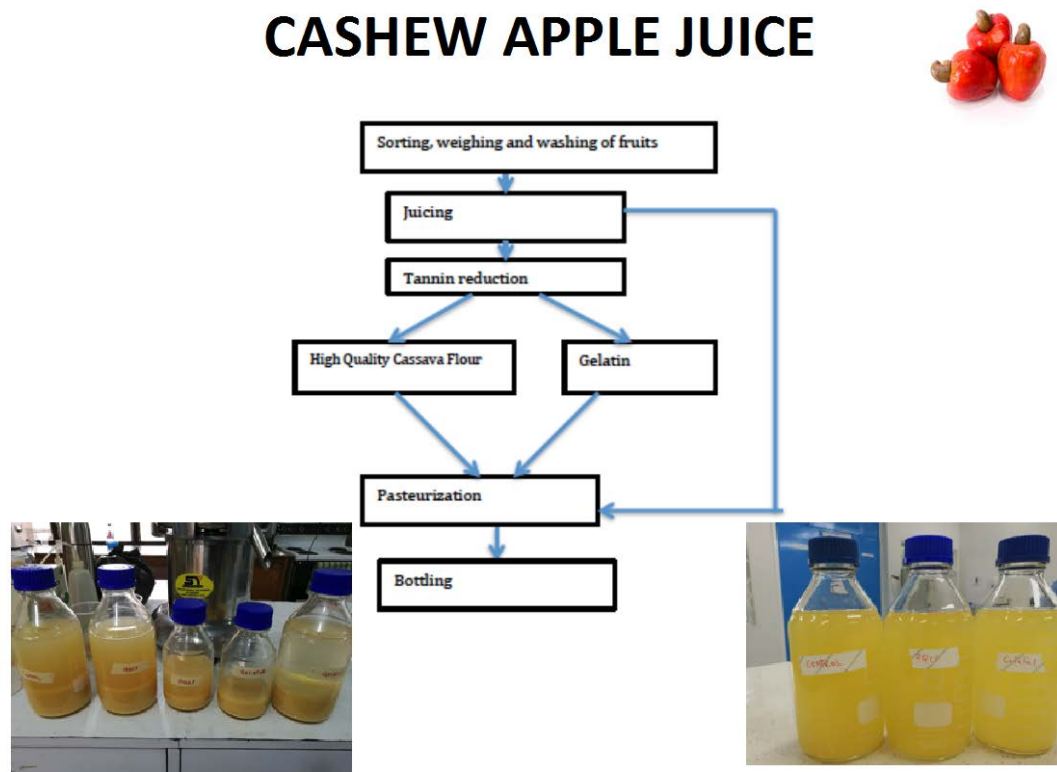


Figure 6: Cashew apple juice preparation

Dehydrated Cashew juice

Cashew juice was spray dried with the different concentrations of either or both of Gum Arabic and Maltodextrin as carrying agents. The inlet temperature was set at 170°C with a feed rate of 20ml/min and an outlet temperature of 75°C.

PROJECT RESULTS

Fresh and dried fruit

- Mean level of Tannin in fresh fruit was 17.23mg/100g, Vitamin C was 83.96mg/100g, Protein was 1.04g/100g and Sucrose was 0.36g/100g
- 4g of 20% HQCF/1L water/1Kg of fresh fruits reduced tannin by 71.2%, Vitamin C by 15.5% and protein by 23.9%.
- 2.5g of 10% Gelatin/1L water/1Kg of fresh fruits reduced tannin by 58.7% and Vitamin C by 11.9% but increased protein by 38.6%
- In dried Fruits, mean level of Tannin was almost 14 times that of the fresh fruit, vitamin C increased about 8 times and proteins increased about 6 times that of a similar weight of fresh fruit.
- To reduce the darkening of the cashew apple fruit dried oven at 65°C, the samples were

placed in a solution of ascorbic acid 1% or in a solution of citric acid 1% for 15 minutes each, before drying. The best results were obtained with the ascorbic acid treatment.

- The control sample was accepted most by consumers eventhough it was accepted slightly

Cashew apple enriched ready-to-eat cereal

- After formulation as well as after 6-month storage E. coli, Yeast & mould, aerobic microorganisms, coliforms and Staph. aureus were all within acceptable limits set by the Ghana Standards Authority (GS 955) in all samples.
- Vitamin C levels reduced over 6-month storage (Lowest loss (1.1%) was observed in the honey-sweetened cereals containing HQCF-treated cashew fruits. Highest loss (47.7% loss) was observed in the sugar-sweetened cereals containing untreated cashew fruits).
- Sugar-sweetened gelatin treated cashew fruit enriched cereal had the highest consumer acceptability on a 9-point hedonic scale (7.69).

Cashew apple juice

- Juice treated with HQCF and pasteurized at 100°C for 3 minutes had the lowest tannin contents.
- After formulation, no microorganism was isolated from any of the juice samples.
- Juice treated with Gelatin and pasteurised at 100°C for 3 minutes had the highest consumer overall acceptability (7.23 on a 9-point hedonic scale)

Dehydrated Cashew apple juice

- Use of maltodextrin as carrying agent produced a better yield and product quality as compared to the use of gum Arabic or a combination of both.
- 19.2% solids, using maltodextrin as the carrying agent was found as the ideal lower limit for juice dehydration in terms of fineness of powder and output by spray drying. However, the yield was low
- 6 media publications (2 TV news, 1 radio, 2 online and 1 newspaper articles) and 300 leaflets were used to disseminate project outputs.

CONCLUSION

HQCF has better tannin reducing abilities as compared to Gelatin. The cashew-enriched cereal containing sugar and gelatin-treated fruits was the most acceptable product formulated. This was followed by Gelatin-treated high temperature pasteurized cashew juice. The least accepted cashew apple product was the Gelatin-treated dried cashew fruits

SCALABILITY AND REPLICABILITY

The results of the project indicated a good consumer acceptance of the cashew products. This means that apart from the products developed, new cashew fruit value added products can be explored in Ghana. This may include cakes, energy bars, jams and other new recipes developed with the cashew fruit in mind. Furthermore, despite the long distance between farm sites and research location, it is still possible to establish factories in the farming communities, as basic raw materials, amenities and utilities are readily available. However,

such production characteristics may result in long distribution channels due to distance between production sites and marketing sites which may result in high distribution costs. If this is not an option, fruits can still be transported under cold storage and kept frozen for at most 6months for use in production

IMPACTS OF PROJECT RESULTS

Current impact:

- Empowerment of farmers on utilization of cashew fruits as food sources
- 3 additional food choices for consumers and food processors
- Improvement of self-confidence of farmers on role they play on nutrition in Ghana
- Public education on potential uses of cashew fruits through media publications and dissemination workshops. Training workshops to sensitize farmers and potential investors on utilization of cashew fruits were held in 2 regions of Ghana with over 100 participants.

Potential impact:

- Increase in consumer consumption of cashew fruit products
- Increased utilization of cashew fruits for value added products
- Production of assorted cashew fruit value added products on larger scales
- Both national and international marketing of cashew fruit products
- Increased food security status in Ghana
- Farmers' gain of extra income from sale of cashew fruits by
- Reduction of post-harvest losses of cashew fruits
- Increased support by government to cashew farmers

SUSTAINABILITY OF PROJECT

During the execution of project activities, new partnerships were made between Ghana and Brazil and it is expected that this partnership will be strengthened and used for future collaborative work, building up on the current project outputs. The project team is looking forward to carrying out different activities related to the utilization of cashew fruits, using available resources. CSIR-Food Research Institute has resources like infrastructure, equipment, laboratories and utilities which can be regularly assessed to pursue other cashew-fruit related activities. Furthermore, food processors seeking new ideas on production regularly come to Food Research Institute. They can also support tailor-made-research into different areas of cashew fruit processing which will be utilized for their production processes.

ISSUES IN PROJECT IMPLEMENTATION

- Bureaucracies related to financing and acquisition of project equipment and materials
 - Short fruiting season of cashew trees
- Destruction of cashew farms in Dodowa which is closer to Food Research Institute, where Cashew fruits would have been sourced from. Cashew fruits were therefore sourced from the Brong Ahafo region, about 600km from the implementing institute. Long distance between cashew farms and research institute, coupled with the poor road conditions made it impossible to compare effect of different storage conditions

on the quality output of the final product since the fruits were chilled during transportation to site and frozen immediately upon arrival.

- Failure of spray drier to produce optimal powder from juice and therefore no analysis done on output (microbiological, chemical and sensory). An accidental breakdown of a glass component of the equipment also set the project back because unfortunately, it could not be replaced or repaired before the end of the project
- Lack of exchange visits between team members of participating countries/institutes due to conflicting schedules and language barriers.
- Fluctuations in power supply

LESSONS LEARNED

- Market research and value chain analysis should have been included in the scope of the study to make the research output more realistic and holistic.
- Regular project updates and meeting between co-partners is critical for the success of any project.
- For the project activities to be carried out as planned, it is important to identify and analyse the SWOT of each potential team member before inclusion as a member in the project
- Feedback from farmers and staff of Ministry of Food and Agriculture indicated the need to have included other areas like economics and business models during project planning and implementation

SUGGESTIONS FOR IMPROVEMENT

- Co-leaders should get to know each other and team members well before project is rolled out
- Understand purchasing regulations and procedure in local institutions
- Identify and commence communication with suppliers of critical project equipment and materials before project is rolled out
- Consider seasonality of raw materials and make appropriate planning before implementation
- Assign duties and consistently monitor and evaluate performance
- Maintain open communication channels for all team members to communicate issues relating with project
- Include market research and value chain analysis to ensure that such new products will be economically feasible
- If the transfer of funds is delayed due to bureaucratic issues like finalization of contract, a new commencement date should be set in agreement between all stakeholders in the best interest of the project

ACKNOWLEDGEMENT

This research was funded by MKTPlace Agricultural Innovations and is a collaborative research between Council for Scientific and Industrial Research – Food Research Institute (Ghana) and Embrapa Mid-North (Brazil)

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