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Review Article

TURNING AGRICULTURAL WASTES TO WEALTH IN NIGERIA: A REVIEW OF CASHEW (*Anacardium occidentale* L.) PEDUNCLE (APPLE) POTENTIALS

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ABSTRACT

Cashew is a tropical tree of immense potentials which produces the popular cashew nuts with cashew apple as important pseudofruit. The apple is juicy and highly rich in vitamin C, phytonutrients, sugars and dietary fibre. It may be considered as a nutraceutic fruit. However, in spite of all the huge potentials of this fruit, it is still underutilized due to some negative characteristics such as astringent taste, high acidic content and high perishability. The apple may be processed into many products such as: cashew apple juice, syrup, wine, alcohol, dietary fibre and animal feed. In Nigeria, there are inadequate technologies and skills in the value addition of the apple and post-harvest handling of this fruit leading to wastage of this highly useful agricultural product. Several studies have described methods of improving the shelf-life of the fruit and removal of the objectionable constituents like tannins. However, more researches are still needed in the possibility of converting the apple to biofuel and animal feed. Farmers also, should be educated on the potential of cashew apple processing. This will lead to more returns for the farmer and may cause a great industrial revolution in the cashew industry in Nigeria.

1. INTRODUCTION

Cashew (*Anacardium occidentale* L.) is a tropical evergreen tree that originated from Brazil and later spread to different parts of the world by the Portuguese during the colonial era (Nair, 2010). Presently, cashew is widely spread in the tropics where it is becoming a major cash crop behind only cocoa in importance, in West African countries, such as Nigeria, Cote d'Ivoire, Ghana, Republic of Benin and Guinea Bissau (FAOSTAT, 2013). Cashew is grown majorly for its nuts which is a highly valued commodity for its shell oil also known as cashew nutshell liquid (CNSL). However, other products such as wood, roasted kernel snacks, kernel oil, juice jams, alcohol and various herbal remedies are derived from the cashew tree. This

has resulted in steady increase in production volumes and sales in the last decade (FAOSTAT, 2013). Furthermore, it is expected that the world market for cashew will remain strong in the foreseeable future due to the considerable potential to the cashew market for high-value by-products, such as cashew nut shell liquid, broken nuts, and cashew shell cake (Boillereau and Adam, 2007; Adeigbe et al., 2015). Interestingly, cashew has been mainly produced in African countries where it is both an agricultural commodity that significantly contributes to gross domestic product and export exchanges at the country level and an essential source for the livelihood of small scale farmers that make up the majority of the producers (Azam-Ali and Judge, 2001; Fitzpatrick, 2011). It has been observed that the cashew industry plays a major role in the economic development of countries like Vietnam, India, Nigeria, Ivory Coast, and Ghana. Therefore, the cashew industry could be exploited for empowering small-scale farmers with a particular focus on women, creating revenue and employment opportunities, and promoting small to medium scale industrialization processes, especially in rural areas.

Cashew was reportedly introduced into Nigeria over 400 years ago but extensive cultivation started only in the 1950's (Adeigbe et al., 2015). In recent years, cashew production has been steadily increasing, which is evident in an increase in the cultivated area from 1,963,000 ha in 1992 to more than 5,000,000 ha in 2012 (FAOSTAT, 2013).

There have been several researches on various aspects of cashew production and marketing, and these include assessment of morphological and molecular characteristics, ploidy status, reproductive biology, development of improved technology for large scale production of value added cashew products, formulation of comprehensive farm management practices, soil and mineral requirements assessments and effective strategies for pest and disease control (Aliyu, 2004, Ibiremo et al., 2012; Oduwole et al., 2001). These efforts have led to improved cashew production in Nigeria with increase in the tonnage of cashew nuts being exported annually.

Cashew is majorly planted for its nut which is about 10% of the cashew fruit while the apple is usually left on the farm to rot away. There is presently no cashew processing facility in Nigeria as the industry is basically export-oriented. Moreover, apart from direct consumption of the apple, there is no reported use of the apple in the country. This review is carried out with the aim of evaluating through literature, the potentials of this valuable part of the cashew fruit as raw materials for food, energy and animal feed industries. This will help to improve farmers' incomes with the possibilities of generating employment to the youths in the country.

2. TAXONOMY AND BOTANICAL DESCRIPTION OF CASHEW

Cashew (*Anacardium occidentale* L.) is a perennial plant belonging to the order Sapindales and family Anacardiaceae. This family is reported to contain about 70 genera and close to 700 species (Adeigbe et al., 2015; Nakasone and Paul, 1998). The Anacardiaceae family comprises of trees and shrubs with high level of resins and gummy exudates. The trees have irregular and short trunk with alternate, green, elliptic, trifoliate or pinnate leaves with smooth margins (Lim 2012). The root system is usually deep and widespread. The root distribution pattern depends on soil type, planting material and method, age, level of crop nutrition, and irrigation (Abdulsalam and Peter, 2010). The flowers may be unisexual or bisexual which usually occur at the end of new shoots of the tree canopy during the reproduction cycle that usually follows dry season. Flowers are gathered in a panicle which may contain male and hermaphrodite flowers. Both of them present a single large stamen and five to nine smaller ones (Martin et al., 1997; Aliyu and Awopetu, 2008). Cross-pollination is by insects, which largely predominates on self-pollination due to the sticky nature of the pollen. The cashew fruit consists of an accessory fruit and the true fruit. The former is a bell-shaped hypocarpium derived from the enlargement of the pedicel and the receptacle of the flower. It is called the "cashew apple" and, on ripening turns yellow and/or red. The latter is a kidney-shaped drupe structure that develops at the bottom of the apple from one carpel (Lim, 2012).

According to Adeigbe et al. (2015), there are 9 identified species in the genus *Anacardium* and they include *Anacardium corymbosum, A. excelsum, A. giganteum, A. humile, A. microcarpum, A. nanum, A. negrense, A. spruceanum* and *A. occidentale*. Out of these, only cashew (*A. occidentale*) is valuable economically, due to its edible apple and nutritious kernel.

3. CASHEW SPREAD AND PRODUCTION IN NIGERIA

Although cashew is originally a native of tropical America, it was introduced in to Nigeria in the 16th century by the Portuguese (Aliyu, 2004). Currently, cashew cultivation has spread to all parts of the country with the advent of higher price tag on the nuts. However, the major producing areas are located in the middle belt area with states such as, Enugu, Abia, Imo, Anambra, Ebonyi, Cross River (in the East), Oyo, Osun, Ogun, Ondo, Ekiti (in the West), Kwara, Kogi, Nassarawa, Benue, Taraba, Niger, Abuja, Kaduna, Plataeu (North Central), Sokoto and Kebbi (North West) among the major producers. According to Adeigbe et al. (2015), there are conflicting records of the production of cashew in Nigeria. The estimated production of 650,000, 813,000 and 835,500 ranked Nigeria second in the world for year 2010, 2011 and 2012 respectively (FAOSTAT, 2013). Presently, Nigeria is ranked third and fifth highest cashew-producing country in Africa and world respectively with 155,000 metric tons production in the year 2015 (ACMR, 2015).

4. CASHEW APPLE HARVESTING AND PRESERVATION

Cashew tree flower for about 10 weeks while the fruits mature about 2 months after the blooming, which usually occur at the end of drying seasons. On ripening, the fruit drops to the ground when wind blows or the tree is shaken. The fruits are then picked, nuts twisted from the apple and the apple discarded on farm as wastes (Azam-Ali and Judge, 2001). The nuts are sundried for about 5 days to reduce the moisture content and enhance the shelf-life (Asogwa et al., 2008).

Cashew apple is highly perishable and deterioration starts immediately after the fruit completely ripens. This is majorly due to its high moisture and sugar content which predisposes the fruit to microbial attack, especially yeast (Sivagurunathan et al., 2010). Moreover, the fruit is poorly accepted in the market because of the characteristic astringent and acrid taste and high tannin content (Jayalekshmy and John, 2004). The quality of the apple and its juice is usually reduced by physical, chemical, biochemical and microbiological changes which bring about sedimentation, browning, and a foul alcoholic smell. The fruits rapidly undergo changes in colour, flavour, texture, appearance, and nutritional value. Therefore, the inhibition of microbial growth and retention of quality are two key parameters for the extension of shelf life of the cashew apple juice (Das and Arora, 2016).

Presently in Nigeria, adequate information is not available for proper storage and processing technologies for the utilization of the cashew apple (Azoubel et al., 2009). This is a major impediment for the conversion of this highly valuable agricultural waste into usable end-products.

5. MAJOR PRODUCTS FROM CASHEW APPLE

Traditionally, cashew is cultivated primarily for food and medicinal purposes, several studies have shown the various uses of different parts of the plant in ethnomedicine. The cashew apple has been reported to have several uses and applications. It may be eaten raw, processed and juice can be extracted from it for both alcoholic and non-alcoholic beverage production. Although cashew apple is generally consumed raw as fresh fruit in the producing areas of Nigeria, many useful and commercially viable products can be produced from the apple. However, cashew fruits are not necessarily popular among Nigerians especially among the elites, various reasons such as its bleaching effect on white fabrics and its high acid and tannin content could be responsible for this (Nwosu et al., 2015; Suganya and Dharshini, 2011).

The fragile and soft nature when fully ripe with its high perishability is another factor that has been suggested to affect cashew fruit acceptability. Nevertheless, if proper processing techniques are adopted, these bottle-necks can be overcome. Various processing methods leading to a variety of cashew products have been reported by Abdulsalam and Peter (2010), Suganya and Dharshini (2011) and Tran et al. (2014). There is a high market potential for cashew apple products in Nigeria if properly processed. The following are major products gotten from cashew apple.

5.1. Cashew Juice

When ripe cashew apple is pressed, good volume of high quality juice can be obtained. The extraction may be done by using cashew juice expeller, screw press, basket press or hydraulic press while the juice can be prepared by pressing, sieving and pasteurizing. The juice can be used neat or by blending with other fruit juices. From the Preliminary investigation carried out in the National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State, 100% cashew apple juice from same fruit variety pasteurized at different temperatures and time resulted in slight differences in flavor and color. This is a good indicator of possible varieties of its juice (Nwosu et al., 2015). Moreover, a blended beverage based on coconut water, cashew apple juice and caffeine were developed by de Carvalho et al. (2007) where all tested formulations showed good microbiological sensory qualities. Presently, two types of cashew juice are commercially available, they are pulpy and clarified cashew juice (Das and Arora, 2016).

The pulpy cashew juice has a higher acceptability in the market than the clarified juice since it retains larger quantities of compounds associated with aroma and flavours of the fruit (da Silva et al., 2000). However, the pulpy cashew juice tends to sediment within a few days of storage and gives an unappealing appearance to the juice. The juices may be preserved using common preservatives (Mathew et al., 2013) and they can be stored for up to 12 months at room temperature. Other methods of preservation have been described for cashew apple juice, these include use of chemical preservatives, thermal treatment, high pressure processing, osmotic dehydration, low temperature storage and modified atmosphere packaging, all of which have their advantages and shortcomings. Nevertheless, cashew apple juice may be blended with juice from other fruits such as orange, grapes, pineapple, mango and lemon. This helps in improving the taste, flavour and acceptability of cashew apple juice and also increasing the nutritional status of other fruits at the same time (Akinwale, 2000).

5.2. Cashew Apple Wine

Many researches have been done in the area of producing wine from cashew apple juice using some organisms and setting specific conditions in the fermentor (Das and Arora, 2016). To produce the wine, cashew apples will first be washed then pressed to extract the juice. This is followed by filtration, steam sterilization and addition of preservatives to kill spoilage microorganisms. The resulting liquid (juice) will then be inoculated with the desired strain of yeast and fermentation allowed for a specific period of time (Mohanty et al., 2006; Prommajak et al., 2014). Cashew wine is usually a light-yellow alcoholic beverage with varying degree of alcohol depending on the fermenting yeast and period of fermentation (Mohanty et al., 2006). In their study, Mohanty et al. (2006) reported that the taste, aroma and flavour of cashew apple wine were inferior to that of grape wine. This may be due to the fact that tannins were not removed from the cashew apple juice before fermentation and the presence of high tannins resulted in an astringent wine taste.

5.3. Alcohol from Cashew Apple

Ethanol can be produced from cashew apple as several reports have described the potential of generating bioethanol from the juice. According to Nwosu et al. (2015), the mean recovery of alcohol from cashew apple is reported to be about 1.5%. Also, Neelakandan and Usharani (2009) optimized the production of alcohol from cashew apple juice using immobilized *Saccharomyces cerevisiae* yeast, they reported a

maximum yield of 7.6%. Furthermore, optimum processing parameters for ethanol production from cashew apple juice was studied by Talasila and Vechalapu (2015) using Yeast extract, substrate and EDTA as independent input variables for optimization, using Doehlert experimental design. The maximum ethanol yield of 68.89 g/l was recorded at substrate concentration of 485 g/l. The medicinal properties of cashew alcohol have been reported earlier by Augustin (2001).

5.4. Dietary Fiber and Animal Feed

The left-over residue of the cashew apple after juice extraction can be dried and used in foods as dietary fiber and also as base for animal feed formulation. After the extraction of juice, the residue may be soaked in water to remove the residual juice then dried and milled into powder. Presently, experimental trials are reportedly going on, at the NCAM, Ilorin, aimed at blending dried cashew fiber with high calorie foods as a means of reducing diet calorie intake (Nwosu et al., 2015). Also, efforts are being made by the authors of this paper currently to produce standardized poultry feed using the cashew apple residue by substituting maize with the cashew apple.

Dried cashew apple may be grounded in to powdered form, this usually possess good sensory properties and could be used as additives in the development of products such as cookies, bread spread, wheat-based confectionaries, chocolates, cakes (Ray et al., 2010).

5.5. Cashew Apple Syrup

The cashew apple juice may be boiled to produce high quality syrup. Nwosu et al. (2015) reported that 750 ml of cashew apple syrup can be prepared from 1 kg of cashew apple. Here, the cashew apple juice is cooked under brisk stirring with or without any additive until it turns to syrup. Preliminary investigation carried out by the same authors at the NCAM, Ilorin, showed that cashew juice can be prepared into syrup without any additive or osmotically active agents, and can stand ambient storage for over six months. Furthermore, syrup produced during this preliminary investigation was stored under ambient condition; proximate composition and microbial load analysis showed that no significant difference has occurred for six months. Cashew apple syrup usually has a sharp sweet taste and good aroma.

5.6. Cashew Apple Extract

The left-over residue when cashew apple juice has been removed usually constitute about 40% of the initial weight of the fruit (Das and Arora, 2014; Tigressa et al., 2008). This residue is under-utilized despite containing an array of useful components that may be appropriated for the betterment of mankind. The cashew apple residue is reported to contain 58% moisture, 1.07% ash, 32% volatile matter, 7.25% reducing sugar, 4.28% starch and 14.2% cellulose (Kuila et al., 2011). Moreover, the presence of several biologically important chemicals has been reported in cashew, these include flavonoids (Lopes et al., 2012) carotenoids (Moo-Huchin et al., 2014), anthocyanins (da Silva et al., 2014), ascorbic acid and reducing sugars (Costa et al., 2009). Recovery of polyphenols from the cashew apple residue before fermentation has been studied with a suggestion that removal of polyphenols would help in improving the fermentation process efficiency of the cashew apple residue (Das and Arora, 2016). The development of technology to harvest these vastly important substances from the cashew apple residue will greatly enhance the value of the cashew apple in Nigeria.

6. CONCLUSION

Cashew is a source of income for many people, including farmers, middlemen, processors in Nigeria and throughout the world. However, the major players in the cashew industry; the farmers, are placed at the lower rung of the economic ladder in the industry because of low price of the nuts which is the major produce

from the cashew farms. The major profits usually go to the middle men and processors involved in the cashew business. Therefore, cashew apple which is currently left to rot on farms has enormous potentials and opportunities for its commercial exploitation through several value addition processes. Cashew apple contain many phytochemicals and nutritional constituents, and its juice presents great potential for the international food and beverage market. The major bottle-necks preventing the full exploitation of the cashew apples are short shelf-life, poor storage facilities, lack of adequate processing technologies and lack of awareness among farmers about the economic returns from the crop especially the apples. Looking at the high nutritional quality and large volume of the cashew apples produced in Nigeria, if properly exploited, its products can contribute enormously to the income of the cashew growers, generate employment for the teeming youths in the country especially in the value addition chain and by extension, generate foreign exchange for the Federal Government through export of the products. Although several researches have been carried out on cashew apple and its nutritional qualities despite its low-level utilization, a number of challenges may still be responsible for its continued under-utilization. Albeit, there are many opportunities for the enhancement of its product diversification, consumption and general acceptability all over the world. Cashew apple can be processed into a variety of products, with high economic and nutritional value, to improve food security in Nigeria.

7. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

Abdulsalam, M. and Peter, K.V. (2010*). Cashew-A Monograph*. Studium Press (India) Pvt. Ltd., New Delhi, pp. 265.

Adeigbe, O.O., Olasupo, F.O., Adewale, B.D. and Muyiwa, A.A. (2015). A review of cashew research and production in Nigeria in the last four decades. *Scientific Research and Essays*, 10(5), pp. 196-209.

African Cashew Market Review (ACMR) (2015). Analysis of cashew production, processing and trade in Africa: General trends and producing country profiles. pp. 1-37.

Akinwale, T.O. (2000). Cashew apple juice: its use in fortifying the nutritional quality of some tropical fruits. *European Food Research and Technology*, 211 (3), pp. 205-207.

Aliyu, O.M. (2004). Characterization and compatibility studies in Cashew (*Anacardium occidentale* L). Ph.D Thesis, University of Ilorin, Nigeria. p. 266.

Aliyu, O.M. and Awopetu, J.A. (2008). Multivariate Analysis of Cashew (*Anacardium occidentale* L) germplasm in Nigeria. *Silvae Genetica*, 56, pp. 3-4.

Asogwa, E.U., Hammed, L.A. and Ndubuaku, T.C.N. (2008). Integrated production and protection practices of cashew, *Anacardium occidentale* in Nigeria. *African Journal of Biotechnology*, 8(1), pp. 53-58.

Augustin, A. (2001). Utilization of cashew apple. In: Souvenir of World Cashew Congress 2001, India. The Cashew Export Promotion Council of India, Cochin, p. 57.

Azam-Ali S.H. and Judge E.C., (2001). Small-Scale Cashew Nut Processing. ITDG Schumacher Center for Technology and Development Bourton on Dunsmore, Rugby, Warwickhire, U.K. pp. 77-123.

Azoubel, P.M., El-Aouar, A.A., Tonon, R.V., Kurozawa, L.E., Antonio, G.C., Murr, F.E.X., and Park, K.J. (2009). Effect of osmotic dehydration on the drying kinetics and quality of cashew apple. *International Journal Food Science and Technology,* 44 (5), pp. 980-986.

Boillereau, N. and Adam, B. (2007). Cashew processing, marketing and consumption in West Africa: current status and opportunities. WATH/Accra technical report No. 22, United States Agency for International Development - USAID.

Costa, J.M.C., Felipe, F.M.F., Maia, G.J., Hernandez, F.F.F. and Brasil, I.M. (2009). Production

da Silva, K.D.P., Collares, F.P. and Finzer, J.R.D., (2000). A simple and rapid method for estimating the content of solids in industrialized cashew juice. *Food Chemistry,* 70(2), pp. 247-250.

da Silva, L.M.R., de Figueiredo, E.A.T., Nagila Ricardo, M.P.S., Vieira, I.G.P., de Figueiredo, R.W., Brasil, I.M. and Gomes, C.L. (2014). Quantification of bioactive compounds in pulps and by-products of tropical fruits from Brazil. *Food Chemistry*, 15 (143), pp. 398-404.

Das, I. and Arora, A. (2016). Post-harvest processing technology for cashew apple-A review. *Journal of Food Engineering*, 194, pp. 87-98.

de Carvalho, J.M., Maia, G.A., de Figueiredo, R.W., de Brito, E.S. and Rodrigues, S. (2007). Development of a blended non-alcoholic beverage composed of coconut water and cashew apple juice containing caffeine. *Journal of Food Quality,* 30, pp. 664-681.

FAOSTAT, (2013). Statistical Databases for Agriculture. http://www.fao.org/docrep/ 018/i3107e/i3107e.PDF.

Fitzpatrick, J. (2011). Cashew nut processing equipment study—summary. African Cashew initiative. http://www.africancashewalliance.com/sites/default/files/documents/equipment_study_ab_pdf_final.pdf.

Ibiremo, O.S., Ogunlade, M.O., Oyetunji, O.J and Adewale, B.D. (2012). Dry matter yield and nutrient uptake of cashew seedlings as influenced by arbuscular mycorrhizal inoculation, organic and inorganic fertilizers in two soils in Nigeria. *Journal of Agriculture Biological Science,* 7(3), pp. 1990-6145.

Jayalekshmy, V.G. and John, P.S. (2004). Sago- A natural product for cashew apple juice clarification. *Journal of Tropical Agriculture,* 42, pp. 67-68.

Kuila, A., Singh, A., Mukhopadhyay, M. and Banerjee, R. (2011). Process optimization for aqueous extraction of reducing sugar from cashew apple bagasse: a potential, low cost substrate. *Food Science and Technology*, 44, pp. 62-66.

Lim, T.K. (2012). *Anacardium occidentale*. In: Edible medicinal and non-medicinal plants, Springer, Netherlands, pp. 45–68.

Lopes, M., Miranda, M., Moura, C. and Filho, J. (2012). Bioactive compound and total antioxidant capacity of cashew apples during ripening of early dwarf clones. *Journal of Food Science Technology*, 36 (4), pp. 430-500.

Martin, P.J. Kasuga, L.J. and Bashiru, R.A. (1998). Cashew farming upgrading: agronomic options for cashew production by smallholder farmers in Tanzania. *Experimental Agriculture* 72, 261-268.

Mathew, J., Sobhana, A. and Mini, C. (2013). Opportunities for income enhancement from cashew plantations through cashew apple processing. In: Proceedings of Security International Cashew Conference, 26-29 April, 2013, Kampala, Uganda, pp. 143-149.

Mohanty, S., Ray, P., Swain, M.R., Ray, R.C. (2006). Fermentation of cashew (*Anacardium occidentale* L.) “apple” into wine. *Journal of Food Processing and Preservation* 30(3), pp. 314–322.

Moo-Huchin, V.M., Estrada-Mota, I., Estrada-Leon, R., Cuevas-Glory, L., Ortiz-Vazquez, E., Vargas, M.L.V., Betancur-Ancona, D. and Sauri-Duch, E. (2014). Determination of some physic-chemical characteristics, bioactive compounds and antioxidant activity of tropical fruits from Yucatan, Mexico. *Food Chemistry*, 152, pp. 508-515.

Nair, K.P. (2010). The agronomy and economy of important tree crops of the developing world. *Elsevier,* 110, pp. 234-249.

Nakasone, H.Y. and Paul, R.E. (1998). Tropical Fruits. CAB International, Oxford, UK. pp. 124-140.

Neelakandan, T. and Usharani, G. (2009). Optimization and production of bioethanol from cashew apple juice using immobilized yeast cells by *Saccharomyces cerevisiae. American-European Journal of Scientific Research*, 4, pp. 85-88.

Nwosu, C., Adejumo, O.A. and Udoha, W.N. (2015). Cashew apple utilization in Nigeria: Challenges and prospects. *Journal of Stored Products and Postharvest Research*, 7(2), pp. 29-31.

Oduwole, O.O., Akinwale, T.O. and Olubamiwa, O. (2001). Economic evaluation of a locally fabricated extraction machine for a cottage cashew juice factory. *Journal of Food Technology,* 6, pp. 18-20.

Prommajak, T., Leksawasdi, N. and Rattanapanone, N. (2014). Biotechnological valorization of cashew apple: A review. *Journal of Natural Science,* 13 (2), pp. 159-181.

Ray, B.R., Vijayalakshmi, D. and Jamuna, K.V., (2010). Formulation and utilization of cashew apple powder in selected foods. *Korean Journal of Agricultural Science* 19 (2), pp. 455-457.

Sivagurunathan, P., Sivasankari, S. and Muthukkaruppan, S.M.J. (2010). Characterization of cashew apple., *Anacardium occidentale* L.) fruits collected from Ariyalur District. *Bioscience Research,* 1, pp. 101-107.

Suganya, P. and Dharshini, R. (2011). Value Added Products from Cashew Apple - An Alternate Nutritional Source. *International Journal of Current Research*, 3(7), pp. 177-180.

Talasila, U. and Vechalapu, R.R. (2015). Optimization of medium constituents for the production of bioethanol from cashew apple juice using doehlert experimental design. *International Journal of Fruit Science* 15, pp. 161-172.

Tigressa, H.S.R., Gustavo, A.S.P. and Luciana, R.B.G. (2008). Effects of inoculum concentration, temperature and carbon sources on tannase production during solid state fermentation of cashew apple bagasse. *Biological Technology and Bioprocess Journal of England*, 13, pp. 571-576.

Tran, N.N., Nguyen, P.M. and Dong, T.A.D. (2014). Investigation of Processing Conditions For Dietary Fiber Production From Cashew Apple (*Anacardium occidentale* L.) Residue. *Journal of Food Technology,* 22, pp. 29-35.