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Quality and safety assessment of a developed solar thermal processing system for cashew *(Anarcardium occidentale)* kernels processing

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Abstract

In many instances, when designing and building equipment for food applications, there exists a gap between efficiency and food safety. Machines are efficient, but the safety of the food that it processes is not considered. These machines are deemed inappropriate once introduced to potential users. The study aims to assess the quality and safety of a developed concentrated solar thermal processing (CSTP) system for cashew kernel roasting for local processors in Cagayan de Oro, Philippines. Microbiological and physico-chemical analyses were conducted and evaluated using the Philippine National Standards (PNS) as reference for specifications. Moisture, color, and microbial content are well within the standards of a maximum of 5%, white to brown, and negative to E. coli and Salmonella, respectively. Breakage during processing from measuring size per kilogram was also very minimal at below 5%. These results show that a localized, cheaper, and readily fabricated CSTP system can produce roasted cashew kernels within PNS and can be adopted for use for a more efficient and quality and safety-compliant processing.

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Introduction

One of the challenges faced by rural farmers is the lack of access to processing equipment that could value add their produce, especially when there is a surplus of harvest. Low mechanization of crops in the Philippines has tremendous impacts on socioeconomic status, labour productivity and farm income, among others (PCARRD, 2009).

There is available equipment in the market, but it is either too expensive or not fit for the farmer's produce. Local fabrication tailor fitting equipment according to the groups of products, i.e., grains, nuts, etc., is seen to be a solution to address the demands for farm modernization with consideration to service that will now be locally available. It has also been observed that the quality and safety of processed products have been a major concern of consumers (FSN, 2020) as well as a basic human right (WHO, 2019). More and more humans are also interested in foods with bioactive compounds for the health benefits these foods provide. In the Philippines and globally, cashew kernels are considered a high-value product due to their taste and bioactive compounds (Alasalvar, 2015). As a major tourist food souvenir in the Philippines, cashew kernels, among other nuts, are always a product that is worthy of assistance, especially in the process of standardization. Roasting being one of the processes has still been done manually even up to today by the majority of cashew kernel local processors. The efficiency of the manual roasting process is low. The availability of roasting machines is minimal, or the price is beyond the capacity of local micro and small cashew enterprises in Cagayan de Oro City, Philippines. Electricity is also sometimes not available on farms and the use of this electricity-based equipment is not practical. To address this, the fabrication laboratory of the USTP has developed a concentrated solar thermal processor that is capable of roasting nuts and other products and is electricity-independent. Therefore, this study is aimed at assessing the quality and safety of cashew kernels roasted using a developed concentrated solar thermal processing system in terms of their physico-chemical and microbial properties.

Methodology

Procurement of cashew kernels

Good quality cashew kernels were procured directly from the farm at Lumbia, Cagayan de Oro, Philippines based on the specifications in the Philippine National Standards for Cashew (PNS/BAFPS 59:2008). The cashew kernels are pre-dried and peeled, ready for roasting.

Roasting of cashew kernels

The plain cashew nuts were roasted in the roasting chamber of the concentrated solar thermal processor. It is roasted at 180°C for 30 minutes with the drum roaster mechanically spinning to ensure equal roasting.

Proximate analysis

Calories, moisture, protein, fat, ash and carbohydrates of the samples were determined using the methods recommended by the OMA AOAC (2007).

Physico-chemical analyses

Color and percent breakage were analysed. The color was analysed through high-resolution photography of cashew kernels from raw to fully roasted at a 10-minute interval and quantified using a Konica-Minolta CR 400 Chroma Meter. Percent breakage is calculated by measuring the total broken kernels and dividing it by the total weight of the kernels and multiplying it by 100.

Microbial analyses

Plain and roasted cashew kernels were subjected to aerobic plate count, yeast and mold count, *Salmonella* detection and *E. coli* enumeration. The methods of analyses were based on the Bacteriological Analytical Manual.

Results and discussion

Proximate analyses

Table 1 shows the chemical composition of cashew kernels. More or less, the values can be compared to those provided by the Philippine Food Composition Table (PhilFCT, 2021) for roasted cashew kernels.

Table 1. Chemical composition (g/100g) of plain and roasted cashew kernels.

Parameter (g/100g)	Plain cashew kernel	CSTP Roasted cashew kernel
Calories, kcal	528.94	618.98
Fat	38.80	46.78
Protein	21.75	17.84
Moisture content	6.14	2.10
Ash	2.45	2.63
Carbohydrate	27.10	31.65

Calories, in kcal, are seen to increase as a result of the loss of moisture and concentration of fat content with the kernels. These results coincide with studies such as that in potatoes (Ramasawmy *et.al.,* 1999) and some tree nuts (Ghazzawi, 2017). Roasting has also resulted in the decrease of protein which can be explained by the denaturation of some amino acids at high temperatures. These are also observed in studies on roasting temperatures and protein in beef patties (Xia *et al.*, 2021), flaxseed meal (Waszkowiak, 2020) and cashews (Yan *et al.*, 2021). Roasting was stopped when the color changed from whitish brown to brown. Table 2 shows that at 35 minutes, the cashew kernels are already in a dark brown color which is no longer desirable. As such, it was determined that the roasting time, provided a temperature of 180°C is reached, will last for 30 minutes to produce safe and quality roasted cashews. The L*a*b* values are also called the tri-stimulus model created by Richard Hunter in the 1940s. The L*a*b* stands for lightness, red/green value and blue/yellow value, respectively.

The higher the L* color means that it is leaning toward the lighter portion of the chart (Xrite, 2021).

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A percent breakage of 3.79% indicates that the spinning motion of the roaster can produce roasted cashew kernels that are of high efficiency in terms of minimal loss from breakage without the need for human labor. There is no breakage percentage for the plain cashew kernels as it was already set to only use good quality cashew kernels for the roasting process.

Microbial analyses result presented in Table 3 show that roasting, although it produces heat that can potentially destroy viable microorganisms, it is not enough to kill a lot (Britton *et al.*, 2021) due to the inherent amount present in the raw material. What is more important is to ensure that the moisture is within the standard as low moisture has a positive effect on the quality (Shirmohammadi *et al.*, 2018) and safety (Shakerardekani *et al.*, 2019) of the product during storage.

E. coli and Salmonella are pathogenic microorganisms that may indicate faecal contamination in food. The absence of Salmonella and E. coli below the acceptable standard of 3 MPN/g (FDA, 2013) indicates that the roasted cashew kernels produced using the CSTP are safe for human consumption.

Table 2. Average color profile of cashew kernels.

Parameter	Plain cashew kernel	CSTP Roasted cashew kernel
Color output		
Time	0 minutes	35 minutes
L*a*b* values	72.47*2.57*20.25	61.55*8.45*27.14
% Breakage	-	3.79%

The reduction of yeast and molds from the plain cashew kernels to the roasted kernels is within expectation, given the low resistance of many yeasts and mold species to dry heat (Scott and Bernard, 1985). A 106/g aerobic count and lower is indicative of an acceptable microorganism's level for nuts (Irtwange and Oshode, 2009). The results may relate to the effectiveness of pre-treatment of plain cashew kernels prior to roasting.

Overall, the microbial results show that the use of CSTP as an economical roaster for nuts is viable.

Table 3. Microbial analyses of plain and roasted cashew kernels.

Parameter (g/100g)	Plain cashew kernel	CSTP Roasted cashew kernel
Aerobic plate count	1.31 10^5 CFU/g	1.20 10^5 CFU/g
Yeast and molds	77 CFU/g	17 CFU/g
E. coli	<3.0 MPN/g	<3.0 MPN/g
Salmonella	Not detected	Not detected

Conclusion

The study has shown that farm mechanization can be fulfilled by local fabrication of an efficient and safe food-producing machine, in this case, a concentrated solar thermal processing (CSTP) system for roasting. With minimal changes in the microbial load before and after roasting, this suggests the importance of following Good Manufacturing Practices during the preprocessing treatments to produce plain cashew kernels. In general, based on physico-chemical, proximate analysis and microbial profile data, the CSTP is suitable equipment for roasting cashew nuts.

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Reference

Alasalvar C, Bolling BW. 2015. Review of nut phytochemicals, fat-soluble bioactives, antioxidant components and health effects. British Journal of Nutrition **113(S2),** S68-S78. https://doi.org/10.1017/S0007114514003729

Britton BC, Sarr I, Oliver HF. 2021. Enterobacteriaceae, coliform, yeast, and mold contamination patterns in peanuts compared to production, storage, use practices, and knowledge of food safety among growers in Senegal. International Journal of Food Microbiology **360,** 109437. https://doi.org/10.1016/j.ijfoodmicro.2021.109437

Department of Trade and Industry – Bureau of Product Standards 2008. Philippine National Standard for Cashew Kernel (PNS/BAFPS **59,** 2008).

Food and Drug Administration 2013. Revised Guidelines for the Assessment of Microbiological Quality of Processed Foods. (FDA Circular No. 2013-010). https://www.fda.gov.ph/

Ghazzawi HA, Al-Ismail K. 2017. A comprehensive study on the effect of roasting and

frying on fatty acids profiles and antioxidant capacity of almonds, pine, cashew, and pistachio. Journal of Food Quality, 2017.
https://doi.org/10.1155/2017/9038257

iFNRI Website. I.fnri.dost.gov. ph. (2021). Retrieved 26 November 2021, from https://i.fnri.dost.gov.ph/fct/library/search_item?fbclid=IwAR1krl4qhlZCLOmoZgy-Jdg0c8wc14PjT5cJgJlfjgVox6g96Wv_CYvw40g.

Irtwange SV, Oshodi AO. 2009. Shelf-life of roasted cashew nuts as affected by relative humidity, thickness of polythene packaging material and duration of storage. Research Journal of Applied Sciences, Engineering and Technology **1(3),** 149-153.

LAB Color Values. X-Rite Pantone. 2018. Retrieved 26 November 2021, from https://www.xrite.com/blog/lab-color-space?fbclid=IwAR2yosHa1TtrTgbzBX_V-OyjBgVzPIPRNuaee-UyP6WYZaoD2-1CjXubYko.

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development 2009. Agricultural Mechanization in the Philippines 1st Edition.

Ramasawmy G, Goburdhun D, Ruggoo, A.1999. Effects of different preparation technologies on proximate composition and calorie content of potato products. Science & Technology Research Journal **4,** 1999.

SCOTT VN, BERNARD DT. 1985. Resistance of yeast to dry heat. Journal of Food Science **50(6),** 1754-1755.
https://doi.org/10.1111/j.1365-2621.1985.tb10585.

Shirmohammadi M, Chandrasekaran I, Singh CB. 2018. Effect of post-harvest processes and storage conditions on aging and quality of fruit nuts. The Canadian Society for Bioengineering.

Shakerardekani A, Mohamadi A. 2019. Effect of Different Salting and Roasting Methods in Oven and Fluidized bed Roaster on the Quality and Shelf life of Pistachio Nuts. Pistachio and Health Journal **2(2),** 26-33.
https://doi.org/10.22123/PHJ.2020.198292.1034

Survey finds food safety primary concern for consumers. Food Safety News. 2020. Retrieved 26 November 2021, from
https://www.foodsafetynews.com/2020/07/survey-finds-food-safety-primary-concern-for-consumers/?fbclid=IwAR3zD_JxBjvhS5iRZeozOZKOxgHUaA6k5dpYgi50p5dX_TVVcdgM36z2Tvk.

Waszkowiak K, Mikołajczak B. 2020. The Effect of Roasting on the Protein Profile and Antiradical Capacity of Flaxseed Meal. Foods **9(10),** 1383.
https://doi.org/10.3390/foods9101383

Weiler D, Fernandez J. 2019. Food safety is everybody's responsibility. Who.int. Retrieved 26 November 2021, from
https://www.who.int/philippines/news/commentaries/detail/food-safety-is-everybody-s-responsibility?fbclid=IwAR30My8TjcuKCFu91hSZ7fqI4BvOHOFGDm7MHz4i3Se_PIzqDujnsr0dq-I.

Xia C, Wen P, Yuan Y, Yu X, Chen Y, Xu H, Wang J. 2021. Effect of roasting temperature on lipid and protein oxidation and amino acid residue side chain modification of beef patties. RSC Advances, **11(35),** 21629-21641.
https://doi.org/10.1039/D1RA03151A

Yan X, Wang Y, Chen Y, Xie J, Yu Q. 2021. Effect of roasting duration on the solubility, structure, and IgE-binding capacity of cashew nut proteins. Innovative Food Science & Emerging Technologies, **68,** 102635.
https://doi.org/10.1016/j.ifset.2021.102635