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The impact of technology innovation on coconut milk extraction for sustainable production

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Abstract
This paper analyzes the impact of technology innovation in coconut milk extraction affecting demand and community preference coping with current utilization in the City of Kabankalan. The first coconut milk extractor designed with screw process, requires two laborers to operate the system. The innovation reduces labor requirement from two to one laborer, utilizing the screw for preliminary pressing and finally use the lifting power of hydraulic jack for the extraction. New designs also came up with a fixed upper plate and use only hydraulic jack for the smooth, efficient and sustainable extraction of coconut milk.
Results shows the demand for coconut milk in the City in the last five years (2020-2025) increases from 880 - 985 nuts/day, excluding processors who also extract coconut milk for their VCO production. Grated Coconut meat demand decreases from 60.23 -10.66%. Fresh extracted coconut milk demand increases from 39.77-89.33% showing the shift of demand. Utilization of coconut milk increased by 49.57% compared to declining demand for grated coconut meat. Shift in consumer preference in readily available coconut milk sold at Php 25.00/160 grams than grated coconut meat at php 50.00/nut manifested by increase of available coconut milk extractors from 1 to 7 units in the last 5 years. It is recommended that materials used in the extraction process must utilize a stainless steel material to reduce the hazard of milk contamination and safeguard the health of the community.

Keywords: Capacity, coconut milk, coconut milk extractor, impact, sustainability, technology innovation

Introduction
Coconuts are considered the most popular fruit worldwide. The fruit consist of 51.7% kernel, 9.8% water and 38.5% shell [1]. The kernel or coconut meat consist of 50-55% coconut milk by volume, is immensely utilized as milk substitute specially for lactose intolerance individual who have problems in digestion, diarrhea and stomach pain [2-3]. Coconut milk comes with an increasingly important ingredient in home cooking as well as in the food processing industries [4]. It is estimated that 25% of the world coconut output is consumed as coconut milk [4]. It is classified as a major and an essential ingredient in the production of a wide variety of food products such as curry, desserts, jam, spread, syrup, cheese, bakery products, ice cream and beverages [5-6].
Coconut milk can be produced at home using readily available grated coconut meat in the market. Clean Cheese cloth material can be utilized and by squeezing with hand, coconut milk is produced [7]. However, due to its tedious preparation and rigorous hand squeezing work, consumers tend to shift in the utilization of readily available fresh pure coconut milk which is now also available in the market [7-8].
As early as 2013, one market vendor invested in the extraction of coconut milk using screw press to maximize extraction [9]. Grated coconut meat is placed inside a nylon net bag and place inside a chamber and pressed against the lower plate with the upper plate being pushed down by screw [10-11]. The unit requires two people in operation, acting on the opposing side of the bar, turning the screw for the process. The screw press is mounted on its base so as to provide stability during the screw turning and pressing operation [12-13].
Research and innovation activities of universities contribute to economic growth in significant ways. A utility model for coconut milk extraction was innovated, utilizing the screw process for preliminary pressing and hydraulic jack on its base to press the coconut meat against the upper press plate supported by the screw [14-16].

Labor requirement was reduced in this method to one operator only. The device also operates without mounting its base considering that it the set -up can even be place on top of the table [17]. Mobility is very high that transfer from one place to the other is very easy and cleaning can be done at the designated place to maintain its hygiene and reducing the risk of contamination [18]. The setup also brings advantage to vendors who sell produce in market day "tabo" considering that every barangay, town and cities in the province of negros occidental have their own specific market day [19]. The design also, encourage other innovators two fabricate their own unit and set up. New designs come up with only the hydraulic jack doing the pressing while the upper part is already fixed [20].

Innovations also provide an opportunity for local designers and manufacturers to help increase in national economic competitiveness [21-22]. With a limited time, labor, capital and still able to maximize extraction capacity and increasing its efficiency contributes to sustainability effort of every individual to reduce waste [23-24]. Unextracted coconut milk in a coconut meat, especially if done manually, provides foul odor after a day, contributing to air pollution aside from increase in waste [25]. Challenge on food production and processing is really critical on maximizing the utilization of available inputs and minimize waste as to help the government attain food sufficiency and sustainability around the country [26].

The demand for dairy products is rapidly on the increasing trend, resulting in insufficient available fresh milk in the market. The need to improve agricultural food production through innovative research necessitates. Government agencies may contribute on the regulating efforts for these kinds of operation. Hygiene must always be a priority of the process, and machineries must pass minimum standards on the utilization of stainless-steel materials for the machines in direct contact to food. While food availability is a major concern, food safety affecting community health must always be secured at all times, considering its impact on the economic side and sustainability of the product at the end. This research is focused on determining the current demand on coconut milk, the extraction methods available, current innovation utilization and its impact on coconut milk extraction available in the city.

Materials and Methods

Mature coconut

Local coconut farmers have always considered copra as a primary product of coconut. Unstable copra price always seems to be a problem for farmers which provide option to sell mature coconuts for fresh coconut milk production and or to further process it to Virgin Coconut Oil (VCO). De-husked coconut is sold by middleman at a cost Php. 22.00 - 25.00/nut, delivered directly to market stall owners with warranty of changing nuts found to be immature, damaged, spoiled during harvesting, de-husking and transportation.

Coconut meat grating

Cutting ang grating of mature coconut starts as early as 3 am due to demand of coconut milk by cafeteria, canteen and restaurant owners for their dishes requiring fresh milk. Current charge of coconut grating per piece range from Php. 15.00 - 20.00 depending on size. Consumers of coconut milk who still used the traditional method of extracting coconut milk have the option to buy de-husked coconut and have it grated or buy directly from stall owners who also offer coconut with grating (figure1). Price of coconut with grating range from Php. 50.00-60.00 depending also on size of the nut. Stall owners utilizes manual mechanical coconut grater power by 1 hp electric motor. Capacity and efficiency on grating depend on the experience and acquired skills of the operator. One mature coconut at the average contain 450 grams of coconut meat.

Fig 1: Coconut grater machine powered by 1Hp motor

Coconut milk Extraction

The available milk extractors in the market includes a screw press and hydraulic jack. It operates using the upper plate for screw pressing and adjustment for upper plate for preliminary pressing and no milk extraction was made. The second process requires operating the jack, positioned at the bottom to lift the plate and pressing it against the screw plate producing the fresh coconut milk. Other innovations provide only hydraulic jack at the bottom plate and the upper plate is fixed for the extraction process (figure 2). Grated coconut meat is placed in a nylon net bag, usually about 2-5 kg depending on the design of the pressing chamber. The process is repeated for second extraction process, using same grated coconut meat arrange upside down in the bucket to maximize extraction. The extraction efficiency of coconut milk extractors ranges from 50-56% by weight of input.

Fig 2: Hydraulic coconut milk extractor machine

Coconut Milk

2 kg grated coconut meat as input load will produce fresh coconut milk for 1.00 - 1.090 kg of coconut milk at extraction efficiency of 50-54.5%. Current price of coconut milk is Php 25.00/ 160 grams of coconut milk. Coconut milk processors also sell coconut milk at a discounted price of Php.150/kg. Fresh coconut milk only stays for 4 hours in stalls, and the rest are refrigerated to avoid spoilage. Usual market time for the coconut milk product is only in the

morning, and refrigerated milk can still be available in the afternoon.

Market stalls operating coconut grating and coconut milk extraction

In the City of Kabankalan, there are three site location of market stalls operating coconut grating and coconut milk extraction. These sites have all been considered with site A located at the market stall area for coconut graters. Site B, the extension sites occupied mostly by coconut milk extractors utilizing the screw press and hydraulic jack extractions process. Site C, on a new extension area mostly used for common market day or "tabo" during Saturday was also considered as part of the study considering that the milk extractors are also present and allowed to process coconut milk extraction throughout the week. VCO processors were not included in the study considering they do not sell coconut milk to any consumers but process their own extracted milk to another product.

Coconut Milk Supply and Demand

Data on demand and supply of coconut and coconut milk available in the city was recorded using interview based on personal accounts of the operators. Average supply and demand for the day was recorded and personal recollection for year 2020 supply and demand during pandemic time. Grating and extraction capacity and efficiency was based on actual field testing and operation. Cost of grating and coconut milk was based on data recorded for the month of May 2025 when this research was conducted.

Results and Discussion

The supply and demand for the grated coconut meat and coconut milk is presented in table 1.

Table 1: Grated coconut meat and coconut milk demand in the City of Kabankalan

Market Site	Stall	Coconut Meat Grating only		Coconut Meat Grating and Milk Extraction		Average Daily Grated Coconut and Milk Extraction Demand	
		Years in Business (years)	No. Of coconut grater (pcs.)	Year starter coconut milk extraction business (year)	No of Units, SP (Screw Press), HJ (Hydraulic Jack) (pc)	Year 2020 (nuts/day)	2025 (nuts/day)
A	A1	15	2	-	-	210	35
	A2	10	2	-	-	140	40
	A3	12	1	-	-	180	30
	sub-total					530	105
B	B1	12	2	2013	1	350	280
	B2	5	1	2020	1	-	130
	B3	3	1	2022	1	-	100
	B4	3	1	2022	1	-	150
	B5	2	1	2023	1	-	120
	sub-total					350	780
C	C1	2	1	2023	1	-	40
	C2	2	1	2023	1	-	60
	Sub-total						100
TOTAL		-	13	-	7	880	985
% Utilization of Meat Grating Alone						60.23%	10.66%
% Utilization of Meat Grating and Innovation on Milk Extraction						39.77%	89.34%

Coconut Grater and Coconut Milk Extractors

Coconut grating was available as early as year 1980 according to one operator who managed his coconut grater for 15 years whom he assumed the business. Screw Press Coconut milk extraction begun in 2013 as an exploratory business requiring a laborious operation, operated by two laborers turning the screw. During pandemic at the year 2020 and onwards, the available extractors increases up to 7 units to date due to demand and shift of priority, patronizing in the utilization of readily available coconut milk.

Demand on Coconut Meat and Coconut milk: Demand for Grated coconut meat in 2020, shows that 530 nuts were consumed/day representing 60.23% of the demand while extracted coconut milk manage to have only 350 nuts/day equivalent to 39.77% (figure 3). Current demand for coconut in the city increases to 985 nuts/day from 880 nuts/day. A slim increase of 105 nuts/day representing to 11.93% increase on total coconut demand in the city. However, there is a shift in preference by the consumers from grated coconut to coconut milk. A sharp decline on grated coconut meat demand from 530 nuts/day to 105 nuts/day comprising only 10.66% of the demand. Fresh coconut milk demand increases from 350 nuts/day to 880 nuts/day with a commanding 89.34% preference by the consumers.

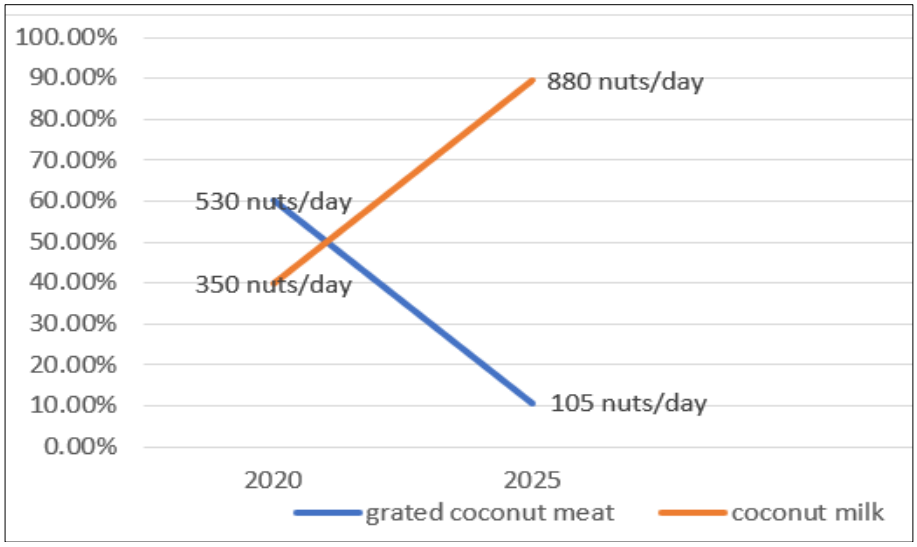

Fig 3: Average daily grated coconut meat and coconut milk demand

Technology Utilization in coconut milk extraction

The hydraulic coconut milk extractor was introduced to screw press operator in 2018 with the utilization of screw for preliminary adjustment and final pressing will be done operating the hydraulic jack. Eventually due to reduction in labor requirement from two to one laborer, the stall owner tried and utilized the innovation and transformed his screw press to combination of screw and hydraulic process (Figure 4). No significant increase in coconut milk extraction was recorded, however capacity was increased due to reduction of labor and ease on force requirement. The innovation was utilized and further simplified by local manufacturers using only the hydraulic process without the screw. At present, there are six units of different design used in the market utilizing only the lifting power of hydraulic jack for extraction.

Fig 4: Innovation transformation from screw press to screw and hydraulic coconut milk extraction

Impact of coconut milk extractor on Coconut milk utilization

The shift preference of consumers from 39.77% to 89.34% is a manifestation of satisfaction for the utilization of readily available coconut milk in the market. Demand is also accompanied by innovators supported by local manufacturers in the utilization of new design in coconut milk extraction. With the current trend, operators of coconut milk extraction need to cope up with more efficient and bigger capacity utilizing even 30tonnes hydraulic jack.

Conclusion

Sustainability on supply of available coconut can be attained through reduction of waste and maximizing extraction of coconut milk utilizing the innovations on coconut milk extractors. The shift in consumer preference in the utilization of readily available coconut milk demand for innovators for further improvement for more efficient and highly productive designs while maintaining hygiene and safety of the product.

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