Imperial Journal of Interdisciplinary Research (IJIR)
Vol-3, Issue-9, 2017
ISSN: 2454-1362, http://www.onlinejournal.in

Design and Fabrication of an Extracting Machine for Small-Scale Production of Local Pomade from Coconut

Odunlami S.A & Ramonu O.J
Department of Mechanical Engineering, Federal Polytechnic, Ilaro, Ogun state, Nigeria

Abstract: *The research conducted and described in this paper focuses on the design, fabrication and performance analysis of an extracting machine for small-scale production of local pomade from coconut.*
The conventional traditional method of extracting oil from coconut is stressful, inefficient and takes longer time. There is need to construct a coconut oil extractor that will help in reducing the Stress experienced by the use of traditional oil extraction method thereby improving the quality and quantity obtained. The fabricated oil extractor consists mainly of five integral parts: The frame, the power transmission Shaft or Plunger, compression chamber, Compression Plate (ram press), electric heater devices and grater.
Several experiments were performed on the constructed coconut oil extractor based on the objectives of this study and the test was performed on both wet basis and dry basis of the coconut. From the results obtained from the wet basis and dry basis, it was noticed that the extractor can perform better when the coconut meat is dried to 10% - 12% moisture content before extraction. However, it is confirmed that, more coconut oil could be obtained from un-matured coconut flesh.

Keywords: *Design, Fabrication, Coconut oil, Extraction, Local pomade*

1. Introduction

Coconut (*Cocosnucifera*) is a member of the family Arecaceae (palm family), a large palm growing up to 30m tall, with pinnate leaves 4–6m long, and pinnae 60–90 cm long. Coconut old leaves breaks away cleanly, leaving the trunk smooth. The term coconut can refer to the entire coconut palm, the seed, or the fruit, which is said to be *drupe* and botanically not a true nut and it is the only accepted species in the genus *Cocos* [1].
The coconut palm may be planted or grown for decorations. It also serves as food in the tropical countries of Africa, Asia the Pacific and South and Central America; virtually every part of the coconut palm can be utilized by humans in various manners. Coconut oil is extracted from the kernel or flesh of matured coconut harvested from the coconut palm (Cocosnucifera). Coconut is available in two forms as wet and dry materials generally known as wet coconut and dry coconut or copra. The oil can be extracted from both of these raw materials.

Oil can be obtained from the fresh, matured kernel (flesh) of the coconut by mechanical or natural means. In his study, [2] concluded that virgin coconut oil is safe for human consumption without further processing while Furman et al. [3], stated that virgin coconut oil consists mainly of oxidation resistant medium-chain triglycerides.
Coconut oil is liquid at about 27°C and above. The coconut oil solidifies at about 22°C when it has the constituent of butter in temperate countries. Copra-derived coconut oil has been produced and used commercially for almost a century. However, [4] has established its use for edibility and inedibility purposes while [5] investigated the major inedible application of coconut oil as a raw material in manufacturing and production industries.
Extraction of the coconut oil can be done manually by pressing the oilseeds and nuts. They are loaded into a hydraulic press to squeeze out the oil-water emulsion. In a screw press, steamed beniseed is pressed slowly, pressure is applied by a plunger forced down by screw and into a cylinder with large number of small holes. Capacities of screw presses depend upon the size of the cage, an average being about 1.5 kg per batch [6].
It is also established by [6] that when a hydraulic press is chosen for the extraction process, high pressure is exerted by the hydraulic device and requires a rigid framed structure.

2. Design analysis and calculation

Based on the various factors considered in material selection, the analysis below shows the materials used for the component/parts of this project.

Design of the Ram disc
The ram disc operates like a piston; the function of the ram disc is to compress the material fed into the chamber due to the axial pressure from the hydraulic press.

$Wp = \delta Vpg$

Vp = Ap x hp $= \frac{\pi d^2}{4} x\, hp$

Therefore,

Wp = 7800 x 1.81 x 10^{-3} x 9.81

= 138.5N

Wp = Weight of the piston,

The frame
The frame was fabricated with 4inches angle iron (50mm x 100mm x 50mm in dimension). The frame is rectangular in shape having length and breadth of 1036mm and 600mm respectively.

Hydraulic Press
Power requirement
The (Torque, T) transmitted by the shaft is obtained from:
T= Fx
The pressure required from the hydraulic press
$P = \frac{F}{A}$
P = pressure exerted by hydraulic press
F = 138.5N
$A = \frac{\pi d^2}{4}$, d = 240mm

$= \frac{\pi(0.240)^2}{4}$ =0.0452m^2

$P = \frac{138.5}{0.0452}$

P= 3064.2N/ m^2

The power required to compress the coconut oil out of the coconut flesh on the maximum applicable load is given by
P = Tω,
$\omega = \frac{2\pi N}{60}$
Where;
N = Speed of rotation = 120rpm
$\omega = \frac{2x\pi x120}{60}$
ω = 12.57m/s
T = 45.71Nm
P = 45.71 x 12.57 = 574.57W
Power = 574.57W

Design of shaft
The required diameter for a solid shaft having torsional load only is obtained from ASME code equation:
Where,
τ = allowable shear stress = 10MPa
T =45.71 x 10^3Nm

D = $\sqrt[3]{\frac{16T}{\tau}}$

D = $\sqrt[3]{\frac{16(45.71)}{10000000}}$

D = 0.04182m
D = 41.82mm

Torsional deflection
The angle of twist (radian), $\theta = \frac{TL}{GJ}$

J = $\frac{TL}{G\theta}$

$\frac{\pi D4}{32}$ = 42 x 0.6 x 180/80x10x 3 = 1.9x10^{-8}

D^4 =32 x1.9x10^{-8}/π

D^4 = 1.92 x 10^{-8}

D= 0.021m = 21mm.

The compression chamber
σ = $\frac{pd}{4t}$

70 x10^6 = $\frac{35x\ 10^6\ x\ 0.120}{4t}$

t = $\frac{35x\ 10^6\ x\ 0.120}{70\ x10^6 x4}$, t= thickness of the cylinder

= 0.15m (15mm).

Torsional springs
The choice of circular diameter helical spring was based on the following equation.

T = W$\left(\frac{D}{2}\right)$,

From the design T = 83.1Nm, W= 210N

D = $\frac{83.1\ x\ 2}{210}$, D=mean diameter of the spring coil

= 0.79m

3. Material Selection and Components Fabrication

A plunger of 25mm shaft was selected to transmit force needed to compress coconut flesh from the hydraulic press. The end of the plunger was suspended at the top of the frame and fastened with bolt and nut (M25), flat bar of 8mm thickness was fabricated and fastened to the upper end of the plunger/ram by 10mm bolt and nut, finally fastened to the frame.
The processing chamber comprises of two cylinder, the first cylinder of the oil extractor was fabricated with perforated materials (mesh) made of 240mm diameter, 227mm long and 2mm thick while The second cylinder of the oil extractor is a non-perforated cylinder with 203mm diameter, 150mm long and 3mm thick. Gate valve (1/2 inches) was welded to the bottom end of the second expression chamber (non-perforated cylinder). The compression/ram plate was designed and fabricated using stainless steel of 8mm thickness and 240mm. Stainless pipe of 8mm thickness and 30mm long was welded at the centre of the compression plate which

aids easy attachment to the plunger by 10mm by 25mm bolt and nut through the hole drilled on the pipe and shaft.

A 1500 Watts electric heater was attached to the oil extractor with a thermostat for controlling the temperature needed for the extraction of the coconut oil while the grater was designed and fabricated using stainless steel of 2mm thickness and 280mm long. The grater was designed using shaft handle and two bearings. The grater was welded and joined to the frame; it is a manual operated grater which has an inlet and outlet for the passage of the grated coconut. The fabrication process included cutting, welding, joining, machining and fitting.

Plate 1: Extracting machine for small-scale production of local pomade from coconut

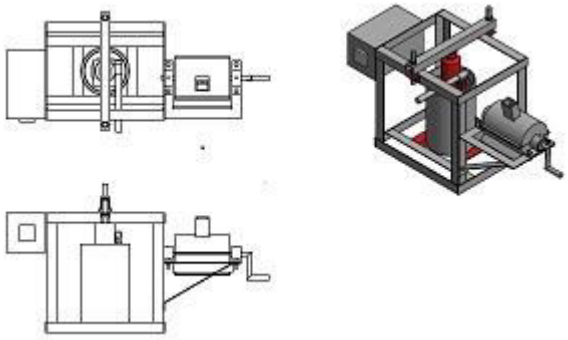

Figure 1: Drawing showing an extracting machine for small-scale production of local pomade from coconut

4. Test Procedure

Several experiments were performed on the constructed coconut oil extractor: The coconuts were obtained from Sayedero market in Ilaro, Ogun state, Nigeria. Each copra coconut was weighed on a weighing machine. A yet to be cracked coconut weighed 1.4kg. Since the coconuts were of different sizes, their weights vary between 0.9 - 1.4kg and were grated manually. The test was carried out for both wet and copra coconut and the colour of the samples were observed at different temperatures until pale colour was noticed.

For wet basis, the yet to be cracked coconut was weighed to be 3.4kg and after cracking (splitting) and grating, it weighed 2.9kg. The grated coconut flesh was then compressed in the compression chamber to extract the aqueous coconut milk; the coconut milk was allowed to settle naturally from the coconut water. The aqueous coconut milk was separated from the coconut water and left to ferment for about 24-48 hours at room temperature after which heat was applied for the extraction of the coconut oil from the fermented coconut milk.

5. Results and Discussion

Several experiments were performed on the constructed coconut oil extractor based on the objectives of this study and the test was performed on both wet basis and dry basis of the coconut. The results obtained were tabulated and explained accordingly.

Table 1: The result of the test for wet basis

Time (min)	Weight of cake (kg)	Temp (^{o}C) of heater	Colour of oil observed during extraction
20	3.0	10-15	Aqueous milk
15	3.0	20-25	Aqueous milk
15	3.0	30-45	Pale yellow

Table 2: The result of the test for dry basis

Time (min)	Weight of cake (kg)	Temp (^{o}C) of heater	Colour of oil observed during extraction
25	3.0	25-40	Pale yellow
20	3.0	41-54	Pale yellow
20	3.0	65-75	Pale yellow

Table 1 shows the color of oil that was obtained at different temperature with 3.0kg weight of coconut (it was extracted for 20min) and above this conditions, it was observed that, the coconut cake got burnt and no oil was obtained. From table 1, it is obvious that the coconut oil will be best extracted at 30-45^{0}C for wet basis. The oil was obtained after allowing the mixture of coconut milk and water to settle for about one hour and filtrated.

Table 2 shows the color of oil after extraction at different temperature using 4.5 Kg of dried coconut. The table shows that the coconut oil was best extracted at 65-75^{0}C for dry basis. The oil was obtained after allowing the mixture of coconut milk

and oil to settle for about one hour and filtrated; 0.8kg of coconut oil was obtained.

6. Conclusion

According to the results obtained from the wet basis and dry basis, it was noticed that the extractor can perform better when the coconut meat is dried to 10% - 12% moisture content before extraction. However, it was also found that, more coconut oil could be obtained from un-matured coconut flesh.

7. References

[1] World Wildlife Fund, 2010, *Petenes mangroves*.eds. Encyclopedia of earth. National Council for Science and the Environment," Washington DC
[2] Fife, Bruce. Coconut cures, Piccadilly Books, Ltd. 2005 pp. 184- 185. ISBN 978-0-941599-60-3.
[3]Furman, R.H., Howard R.P., Brusco O.J., Alaupoic P., "Effects of Medium chain length triglyceride on serum lipids in medium chain triglyceride". U Penn Press Pennsylvania, 2006, pp 51-61.
[4] Banzon, J.A., Gonzales de Leon O.N., Sanchez, S.Y. and Sanchez, P.C. "Coconut as food" 1990. PCRDF. Quezon City. Philippines.
[5] Pattra, Maneesin, Anchalee Kamolratanakul, "Development of Retail Packaging for Soap Bars from Coconut Oil", 2004, TISTR, Thailand.
[6] Potts K.H and Machell K.., "The Manual Screw Press for Small Scale Oil Extraction". KIT Publications, 1993, pp 103-105 Southampton Row, London, WC1B 4HH, UK.
[7] Kabara, J. J., 2000. Health Oils from the Tree of Life (Nutritional and Health Aspects of Coconut Oil). Paper delivered at the Asian and Pacific Coconut Community (APCC) COCOTECH Meeting held in Chennai. India.
[8] The Philippine National Standard for VCO (PNS/BAFPS 22:2004/ ICS 67.2000.10)