

DESIGN AND DEVELOPMENT OF THE OIL EXPELLER

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*To my beloved wife, mum, dad, bless his soul and not forgetting Aisya
Qistina my daughter.*

ABSTRACT

The need for new designs of oil expeller is base on the cost and efficiency of the machine especially for the usage in small and medium size industries. It has to be cost effective and light weight to accommodate such demands. The existing oil expellers in the market are too big and too expensive for these small medium size businesses to invest on. Other limitations are its maintenances aspect as well as its operations. Therefore series of survey and interviews will be done to identify the needs and base on that the Final Design Specifications can be synthesize. The Oil Expeller functions like a screw type machine, which presses oil seeds through a barrel-like cavity. Raw materials enter one side of the press and waste products exit the other side. The machine uses friction and continuous pressure from the screw drives to move and compress the seed material. The oil seeps through small openings that do not allow seed fibre solids to pass through. Afterward, the pressed seeds are formed into a hardened cake, which is removed from the machine. This machine will satisfy the demand for the small and medium size industries because of its design, functionality and price. The measurements of the performance also being analyze by calculating the design efficiency. The resulting generalized model is validated through computer simulations and experimental ANNOVA.

ABSTRAK

Projek ini berlandaskan kepada langkah-langkah serta proses yang dibentuk mengikut piawaian Boothroyd Dewhurst dalam merekabentuk dan pembaharuan mesin Pemerah Minyak (Oil Expeller). Metodologi DFMA ini akan menjadi landasan projek ini. Mesin pemerah minyak secara komersial selalunya berfungsi secara putaran skru dimana ia memerah bahan mentah seperti kacang didalam silinder. Bahan mentah akan dimasukkan disatu pembukaan dan sisanya akan dikeluarkan pada penghujung silinder. Ia menggunakan konsep geseran dan tekanan yang berterusan dari skru tersebut. Ia bertindak menekan dan memerah bahan tersebut sehingga minyak dikeluarkan. Disamping itu juga bahan mentah atau sisa juga turut terhasil. Mesin ini direkabentuk agar dapat memenuhi permintaan dari industri kecil dan sederhana melalui rekabentuknya, fungsinya, dan harganya. Tahap efisien mesin ini juga akan diukur dan data akan dianalisa menggunakan perisian Design Expert bagi prosedur ANOVA

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LIST OF ABBREVEATIONS

A	-	Area of Opening
ANOVA	-	Analysis of Variances
BD	-	Boothroyd Dewhurst
Cm	-	Centimeter
DfM	-	Design for Manufacture
DOE	-	Design of Experiment
FAO	-	Federal Agriculture Organization
FOS	-	Factor of Safety
Hp	-	Horsepower
Hr	-	Hours
Hz	-	Hertz
IAR & T	-	Institute of Agricultural Research and Training
Kg	-	kilogram
M	-	meter
MFP	-	Manufacturing process
Min	-	Minute
Mm	-	Milimeter
Mm	-	milimeter
<i>N</i>	-	Screw speed
N	-	Newton
Oy	-	Oil yield
R	-	Radius
RM	-	Ringgit Malaysia
RPM	-	Revolution Per Minute

Sec	-	Second
V	-	Voltage
W	-	Watts
τ	-	Torque
ω	-	Rotational speed

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter discusses the background of the existing oil expellers in the market, the needs of oil expeller in oil production industries, the development of oil industries especially in developing countries. It is followed by the overview of the product which is the oil produces in the market and continued with the overview of the materials of the product by the oil expeller.

The problem statements of the project will be mention in this chapter also. The objectives of the project will define the project as a whole. In this chapter also the scopes of the project will be narrowed down to the most significant.

1.2 Background of problem

The Oil Expeller is a screw type machine, which presses oil seeds through a caged barrel-like cavity. Raw materials enter one side of the press and waste products exit the other side. The machine uses friction and continuous pressure from the screw drives to move and compress the seed material. The oil seeps through small openings that do not allow seed fiber solids to pass through. Afterward, the pressed seeds are formed into a hardened cake, which is removed from the machine. Expeller pressing (also called oil pressing) is a mechanical method for extracting oil from raw materials. The raw materials are squeezed under high pressure in a single step. When used for the extraction of food oils, typical raw materials are nuts, seeds and algae, which are supplied to the press in a continuous feed.

If we scale down the Industrial Oil Expeller we can see that the main workings of the expeller is the helical thread in the barrel that creates a large amount of force pressing the raw material in the process of expelling the oil. The best scale down version of the helical thread is to use a screw press in a cage barrel or press chamber. It will run as a miniature expeller and it will be cost effective for a setting up a small business. In other words the Oil Expeller in this report is a miniature or a scale down version of its industrialize cousins.

The design of the oil expeller needs to be suitable for small-medium businesses where the total cost of setting up and running the machine is low. Although it is at a low cost but yet it must be very efficient in expelling oil. The profitability of oil processing depends on reducing the capital and operating costs as much as possible, and at the same time maximizing the income from the sale of oil and by-products. A careful study of all costs should be undertaken before setting up a production unit.

As justification of the design and the development of the Oil Expeller we can say that the design must be efficient and low in cost. This will increase the productivity of the small medium business and furthermore help the community by receiving socio economic benefits. Among them are;

1. Encourage rural development as wealth and self-employment jobs are generated in villages.
2. Save transport expenses for carrying oilseeds to cities and bringing oil from cities.
3. Consumers empty tins can be refilled and hence costly packing expenses can be saved.
4. Make pure, fresh natural oil available to villagers from their own oilseeds on custom milling basis. So villagers are saved from profiteering, adulteration, taxations etc.
5. Encourage entrepreneurship among them.
6. Eliminate exploitation by middlemen and traders, as consumers have direct contact with mills.
7. Encourage animal husbandry by making oilcake available as best cattle feed. It increases milk production considerably
8. Create confidence and enthusiasm among villagers and their youngsters to run and manage rural industries. This is the greatest benefit as it accelerates creative entrepreneurship for other industries also.

The oil Expeller can produce oils extracted from a number of fruits, nuts and seeds for use in cooking and soap making or as an ingredient in other foods such as baked or fried goods. Oil is a valuable product with universal demand, and the possible income from oil extraction is therefore often enough to justify the relatively high cost of setting up and running a small-scale oil milling business. Oil can be extracted by pressing softer oilseeds and nuts, such as groundnuts and habattul sawda (black seeds), whereas harder, more fibrous materials such as copra and sunflower seed are processed using higher compressing forces. Pulped or ground material is

loaded into a manual or hydraulic press to squeeze out the oil-water emulsion. This is more efficient at removing oil than traditional hand squeezing, allowing higher production rates.

There are a lot of categories of oil producing crops from seeds, plants and even nuts. In Malaysia palm oil is the main crop that produces oil for exports and local demand. It has a lot of usage and commercial value. For small businesses the oil produce is directly use and also sold for local usage. Let take the coconut as an example. Coconut oil is extracted from the kernel or meat of matured coconut harvested from the coconut palm (*Cocos nucifera*). Throughout the tropical world it has provided the primary source of fat in the diets of millions of people for generations. It has various applications in food, medicine, and industry. What make coconut oil different from most other dietary oils are the basic building blocks or fatty acids making up the oil. Research had been done for its medicinal and health properties such as;

- Coconut oil is antiviral, antifungal (kills yeast too) and antibacterial. It attacks and kills viruses that have a lipid (fatty) coating, such as herpes, HIV, hepatitis C, the flu, and mononucleosis. It kills the bacteria that cause pneumonia, sore throats, dental cavities, urinary tract infections, meningitis, gonorrhea, food poisoning, pneumonia, and many, many more bacterial infections. It kills the fungus/yeast infections that cause candida, ringworm, athletes foot, thrush, jock itch, diaper rash and more.
- Coconut oil is called the "low fat" fat. It actually acts like a carbohydrate in that it is quickly broken down in the liver and used as quick energy. It is not stored like other fats. It boosts one's energy and endurance. Many athletes use it blended into their drinks. It also supports thyroid function and increases your metabolism (great if you want to lose weight).
- Coconut oil improves digestion and absorption of fat soluble vitamins, minerals (especially calcium and magnesium), and amino acids. It improves the body's use of blood glucose and improves insulin secretion and absorption (great for type II diabetes). In fact, many diabetics (type I and type

II) use it to reduce their symptoms. One's risk of diabetes decreases with regular use of coconuts and coconut oil. And as we already mentioned, cooking with coconut oil does not create any harmful byproducts.

- Coconut oil helps the body heal and repair faster. It aids and supports immune function, protecting us from a variety of cancers.
- Coconut oil, contrary to much hubbub, is good for your heart. It keeps our blood platelets from sticking together (and causing dangerous clots). Regular users of coconut oils have a much lower chance of atherosclerosis (clogging of the arteries), arteriosclerosis (hardening of the arteries), and strokes. Coconut oil can lower your blood pressure.
- Coconut oil is a natural antioxidant. It protects the body from free radical damage and prevents premature aging and degenerative diseases.

Malaysia is blessed because of the quantity of nuts available in this country. Peanut, cashew nuts and others also have commercial value for its oil. Peanut oil is pressed from peanuts, which contain between 40 and 50 percent oil. Most peanut oil comes from a specific variety of the peanut plant (*Arachis hypogaea*) that has been bred to produce healthier oil. Peanut oil was first produced in the early 1900s in the United States. Today, most of the peanuts that are grown locally are eaten rather than turned into peanut oil. However, in other areas of the world such as Africa and Asia peanut oil is especially popular. India and China, the two countries that produce the most peanuts in the world, use 80 to 90 percent of their crops to make peanut oil. Therefore we know that there are marketable values for the oils.

Just like the sunflowers used to make sunflower oil, the peanut plant has been genetically bred until its peanuts produce oil with a higher level of monounsaturated fatty acids. This made the oil healthier because monounsaturated fatty acids have been shown to reduce cholesterol levels. The oil also has a longer shelf life because it contained smaller amount polyunsaturated fatty acids that are prone to oxidation. The peanut oil made from these plants contains about 45% monounsaturated fatty acids, 38% polyunsaturated fatty acids, and 17% saturated fatty acids. One newer notable variety developed several years ago in Florida is called "Sun Oleic 97R". This

variety has over 80% monounsaturated fatty acids, making it comparable to olive oil and sunflower oil.

Peanut oil can be found in most well stocked grocery store; however it generally costs a bit more than regular vegetable oil. It will keep in a dark cupboard for a half year to a year. The oil has a very mild smell and taste similar to peanuts. One of the major benefits of peanut oil is that it has a high smoke point of over 450 ° F. Cooks often use peanut oil when cooking foods at a very high temperature, such as deep frying and stir-frying. It is often used in salad dressings, marinades, and baked goods. Peanut oil can also be found in massage oils and soaps.

As a muslim we practice sunnah as much as possible thus commercializing Habbatusawda oil can be a new Halal Hub product with tremendous commercial value. For centuries, the Black Seed herb and oil has been used by millions of people in Asia, Middle East, and Africa to support their health. An aromatic spice, similar looking to sesame seed except black in color, it has been traditionally used for a variety of conditions and treatments related to respiratory health, stomach and intestinal health, kidney and liver function, circulatory and immune system support, and for general overall well-being. Black Seed is also known as Black Cumin, Black Caraway Seed, Habbatul Baraka (the Blessed Seed). Studies at international universities and articles published in various journals have shown remarkable results supporting its traditional and been recorded. While the Black Seed is highly effective by itself, ongoing studies with the combination of other herbs have produced remarkable results. Amazingly Black Seed's chemical composition is very rich and diverse. Aside from its primary ingredient, crystalline nigellone, Black Seed contains 15 amino acids, proteins, carbohydrates, both fixed oils (84% fatty acids, including linolenic, and oleic), and volatile oils, alkaloids, saponin, and crude fiber, as well as minerals such as calcium, iron, sodium and potassium. There are still many components in Black Seed that haven't been identified.

With the 3 examples we can see that there are tremendous potential and marketability for producing oil from these raw materials. It is widely available in Malaysia and it can be used for the small medium size industries to produce this oil for local market and in fact they can use to produce products based on the oil obtained. There are more plants, seeds and nuts that can be used to produce oil. Table 1 shows the raw materials and the oil producing properties as well as its commercial value.

Table 1.1: Raw Materials And Its Oil Producing Properties [K. Anderson, 2005]

	Moisture content (%)	Oil/fat content (%)	Yield of oil (%)	Uses for by-products
Seeds and beans				
Cotton	5	15-25	-	Animal feed
Rape	9	40-45	25	Animal feed (needs detoxifying)
Mustard	7	25-45	-	-
Sesame	5	25-50	45	-
Sunflower	5	25-50	20-30*	Animal feed
Safflower	5	30	-	Hulls used for chicken litter, presscake for animal feed Animal feed
Nuts				
Coconut (fresh)	40-50	35-40	55-62	See Figure 8
Copra	3 – 4.5	64-70	-	-
Groundnut (shelled)	4	28-55	40*	Food, snacks, soup
Palm kernel nuts (shelled)	-	-	45-49	Animal feed
Shea nut	-	46-57	47-51	Animal feed, fuel (shells)
Shea nut	-	34-44	15-45*	Fuel
Shea nut	-	-	60	
Fruits				
Oil palm	-	58	11-20	Fuel, lighting
Avocado	89	11-28	40-44	-
Olive	50-70	-	25	Animal feed, fuel

Malaysia's palm oil industry is arguably the most mature in the world, and its productivity among the highest. Government has played an essential role in developing settlement schemes for estate land, and established institutions for research, planning and enforcement of policy. Malaysia's Third National Agricultural Policy for the period 1998-2010, proposed to raise productivity and intensify land use to improve the sector's competitiveness, accomplished by expanding and modernizing domestic food production and management, encouraging large scale and organized agriculture, and shifting agricultural production from mono-cropping to mixed farming as well as from monoculture to poly-culture. Notably absent is expanding land use for agriculture to new areas. This show an interest in agriculture based industries especially in oil base agriculture product.

Malaysia is interested in developing new oil for food industries and others usage, rather than only depending on the palm oil. The largest impacts on the oilseed sector from trade liberalization will be on vegetable oil through higher prices and increased international trade and production. Malaysian palm oil production and exports will therefore increase to some degree, although land and labor availability are serious constraints. Nevertheless there will be both expansion of plantations and replanting with new oil producing crops with higher yielding seedlings.

By looking at the Table 1.2, we can see that Malaysia is one of the major producers of agriculture base oil. Palm Oil is the main source of product for Malaysia. There are varieties of oil seeds and vegetables oils that can be tapped by Malaysia rather than only palm oil. That is why the rationale of having small business and industries beginning small by producing oil from oilseeds and others. Just like the saying “to bend the bamboo starts when it is still young”. Therefore the design and development of the oil expeller may help in realizing the nation’s vision in involving globally as one of the major agriculture base oil producers. The oil expeller may reduce the cost of setting up this business because oil expelling machine are sold for big industries and they are costly.

Table 1.2: Key World Oilseeds Statistics [M. Rieger, 2005]

Key World Oilseed Statistics (2002/03 – 2004/05 Average)		
Commodity	Production	Exports
	million metric tons	
Oilseeds		
Soybeans	205	60
United States	76	27
Brazil	56	21
Argentina	33	8
China	17	-20
Rapeseed	38	5
EU-25	12	<1
China	11	<-1
Canada	6	3
Other oilseeds	109	5
Total	352	70
Oilseed meals		
Soybean meal	133	45
United States	34	5
Brazil	23	15
Argentina	20	19
China	21	1
Other oilseed meals	60	12
Total	193	57
Vegetable oils		
Palm oil	29	21
Malaysia	14	12
Indonesia	11	7
Soybean oil	29	9
Other oils	43	8
Total	101	38

Source: Foreign Agricultural Service, USDA

1.3 Overview on the material of the product (oil)

Basically the Oil Expeller will be design base on the material that can easily machined, available and of course at a low cost. Overall the Oil Expeller is made from Aluminium and Stainless steel due to its rigidity and machining properties. Furthermore both materials are corrosion resistant therefore maintenance and cleaning of the machine can be done. Most of the parts on the machine need to be able to withstand vibrations and forces exerted on the machine. The most critical part is the screw press which is made from Stainless Steel because of the pressure exerted by the screw press to expel oil from the seeds and other by products.

1.4 Problem Statements

What are the quantifying effects on the processing parameters leading to the oil extraction rate produced by the design and developed of the oil expelling machine for Malaysia's small medium industries?

Related questions to the project

- What are the important needs to be considered?
- What are suitable concept designs to develop the model?
- Does the Oil Expeller satisfy all the requirements set by the Small Medium-Size Industries in Malaysia?

1.5 Objectives of project

The objectives of this project were as follows:

1. To design and to develop an affordable oil expeller for small and medium size industries in Malaysia.
2. To evaluate the effects of the screw speeds (N) and the area of opening (A) on the oil yield (O_y)
3. To determine significant process parameters that influences the oil extraction rate.

1.6 Scopes of project

The research activities were limited to the following scopes:

1. The study was limited to design and to develop an affordable oil expeller for the small medium industries in Malaysia
2. The maximum capacity of the proposed machine is between 500g – 1kg.
3. Two different raw materials will be tested using the proposed machine.

The mechanism or conceptual design model need to be generated at the beginning. Then the best design concept model is selected and tested as well as the analysis will taking place after selection has been made.

The analysis consist of identifying and quantifying the area(parameters) that contribute to the improvement in production area. Then correlating those parameters and establish the mathematical model to represent the variable interaction.