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## Development of equipment for making homemade laundry soap

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Simple, easy to maintain and shop floor size pedal-powered soap mixer, mold, cutting and stamping machines were developed, fabricated and tested for local soap production. Soap production can be enhanced by making use of this pedal-powered soap mixer, which with little human effort makes the soap to properly mix and trace within few minutes. The mold made from high strength wood is simple, cheap and can withstand the temperature of the hot soap solution without any adverse effect on the final product. The soap cutting and stamping machine makes cutting and stamping easy, faster and neater than using ordinary knife and manual stamping machine. The soap produced was fairly hard, form good lather and fair to the skin when used for washing. The soap making machine assembly is cost effective and can be a model for a one-shop soap factory for low income earners in developing countries.

**Key words:** soap mixer, mold, stamping machine, soap production, cost effective, low income earners

### Introduction

Soap remains an essential ingredient in modern living, used daily for medicinal, laundry purposes, household cleansing and personal hygiene. Until recently its production remained a primitive art, its manufacture being essentially the treatment of fat with alkali, a chemical process which is the same whether production is done in a backyard or in a factory. The simplicity of the process has led to its worldwide practice as a small business operation (LEAP, 2010). Traditional soap making demands hours of stirring by hand and in the local soap industry, production involves strenuous human efforts. The mixing of ingredients is done manually with a stick or wooden ladle and this requires a lot of energy and time input by the soap producer. The final product is usually not uniformly mixed due to fatigue usually suffered by the operator (Ajao *et al.*, 2010). Large factory operations are exclusively based on the modern continuous process, which produces soap in about 15 minutes but requires

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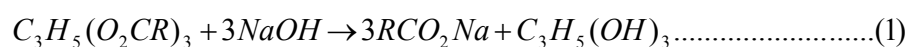
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machinery that is expensive, and demands close production control and a very large output is required to be economical. Soap can still be effectively manufactured by the traditional batching method, which is a week-long, slow, open-vessel process that requires supervision to ensure a good product, but can be undertaken by relatively unskilled operators. Initial startup operations typically employ the batch process until the economies of production are developed and the market demand requires investment in the more expensive continuous process (LEAP 2010) Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system. This technology is most commonly used for transportation and has been used to propel bicycles for over many years. The soap mixer consist of a bicycle pedalled chain drive and gear amplification system that turns impeller blades in a large stainless steel container, where soap ingredients are stirred and pour into a mold to set. Mixing requires only modest amounts of power achievable by an average cyclist; this procedure makes soap mixing easier and saves time (Ajao *et al.*, 2010)

### Materials and methods

Soap making or the saponification process is done by the reaction fatty acids and caustic alkali, the properties of the resulting soap depending on the mixture of fats used, the kind of caustic alkali and the actual process employed. Caustic soda is most often used but caustic potash, or a mixture of the two is also suitable but potash produces a finer product. Sophisticated items such as perfumed bath preparations require prior bleaching and deodorization of the fats to achieve the color, odour and performance features desired in the finished bar (LEAP, 2010).

The basic reaction in soap making is that between a fat or oil and an alkali that results in soap and glycerol:



Where: *R* is the carbon chain which can consist of between 8 to 18 carbon atoms (Colgate-Palmolive, 2009).

In soap production, materials used are mostly based on the use of the soap. There are different types of oil and fat which may be used but in the present work, palm kernel oil was used. This is the type of oil that is commonly used for production of soap in this locality and it is relatively cheap when compared to other oils and fats.

Palm kernel oil is mainly made up of carbon chains of 12 and 14, giving a quick lather, which is however not very creamy. On the other hand, palm oil is mainly made up of carbon chains of 16 and 18. These do not produce lather readily, but have creamy consistency. Soda ash is the preferred neutralizing agent, because it is cheap and because of its lower metallic impurities. These impurities can have a long term effect on the soap colour stability. The use of soda ash results in the release of CO<sub>2</sub> and this aid indirectly in the removal of some of the volatile odours and impurities. The fatty acids and soda ash solution need to be heated since the neutralization is an endothermic reaction. Also the reaction results in incomplete conversion of fatty acids and therefore has to be finished with a small quantity of caustic soda. The soap that is produced after the final caustic soda neutralization is called neat soap having approximately 65% soap and 35% water and traces of excess caustic and salt ((Ajao *et al.*, 2010). . Soap finishing consists of addition of fragrances, deodorant ingredients and colours (Ogunniyi,2010). Mixing is to produce a more uniform mixture of the constituents. In some cases, an important part of the mixing operation is the transfer of materials to or from surfaces of particles or phases and temperature difference exists in the bulk fluid or between suspended particles and the continuous phase. In the local soap industry, production involves strenuous human efforts. The mixing of ingredients is done manually with a stick or wooden ladle and this requires a lot of energy and time input by the soap producer. The final product is usually not uniformly mixed due to fatigue; this mixer is expected to overcome some of the problems associated with local soap production (Ajao *et al.*, 2010).

The average power produced by a man is approximately 75W (0.1 hp), if he works continuously, therefore human power may be used for a process if the power requirement is a maximum of 75W. If process power requirement is more than 75W and if the process can be of an intermittent nature without affecting the end product, a human-powered machine system can be employed. Essentially, the machine shown in Fig 1; consists of three sub-systems: (1) the energy unit (2) transmission mechanism (3) the process unit. The energy unit consists of a conventional bicycle mechanism, the transmission unit consists of a drive train; a chain drive mechanism running over a pair of speed-increasing gears and the process unit is a stainless tank/vessel where impeller blades stirs and blend the soap mixture. The machine should principally have efficient velocity ratio obtained by maximizing gear ratios in order to minimize the energy requirement on the effort end and will have a low center of gravity for increased stability (Ajao *et al.*, 2010). The shape and color of the soap were the two most important factors that determine the appearance of the soap. Almost anything that hold liquid can be used as a soap mold, cardboard boxes lined

with wax paper, plastic tubs, heat-resistant glass containers, wood, stainless steel, and anything that is not aluminum. Wooden soap molds are exceedingly popular within the homemade soap making community and for very good reasons. First of all, wood is a great insulator making it an ideal material for a soap mold. During soap making process, soap solution was drastically increased in temperature due to the chemical reaction that occurs when lye is mixed with oils and it is widely considered to be best practice to let that heat diminish gradually allowing the soap to "cook" and cure from the heat of the reaction. Wooden soap molds were also less expensive, durable and offer more advantages than molds made out of synthetic materials.

The triple loaf mold used in this work was made from high strength wood and it was the following dimensional characteristics: outer dimension (900 x 480 x 300 mm), inner dimension (265 x 430 x 280 mm). The mold was braced at both ends along its length to facilitate easy lifting of the mold and also lined with polythene bag to prevent; the soap from sticking to the mold surface and loss of water from the soap solution when poured.

The simple electric motor-driven machine used for cutting and stamping the soap was the following dimensions in its cutting region: total length (360 mm) and width (275 mm). The width was divided into three equal portions of 88mm each.

After the soap was solidifies, it need to be cut into bars and tablets which small in size for easy use. Subsequently, the soap tablets were stamped with the inscription of the University of Ilorin logo on the machine.

## **Results and discussion**

For the cold process method of soap making used in this work, and by making reference to standard saponification table, the quantity of used materials is depicted in Table 1.

During the soap making process, 2 kg of sodium hydroxide was dissolved in 5 litres of water and stirred to ensure proper mixing. The solution was left for about an hour to allow the solution to cool down to about 42°C since the resulting chemical reaction generates substantial heat. 15 litres of palm kernel oil was heated to about 40°C and poured into the mixing vessel before sodium hydroxide solution was gradually added to it in the mixing vessel and stirred vigorously by driving the pedal-powered mixer.

When the soap began to trace, other additives such as sodium sulphate solution, soda lime, soda ash solution, colorant and perfume were added while the mixing process continues until the trace became thicker. The traced soap

was then poured gradually into the mold through the mixer's tap opening and left in the mold for about 40 hours.

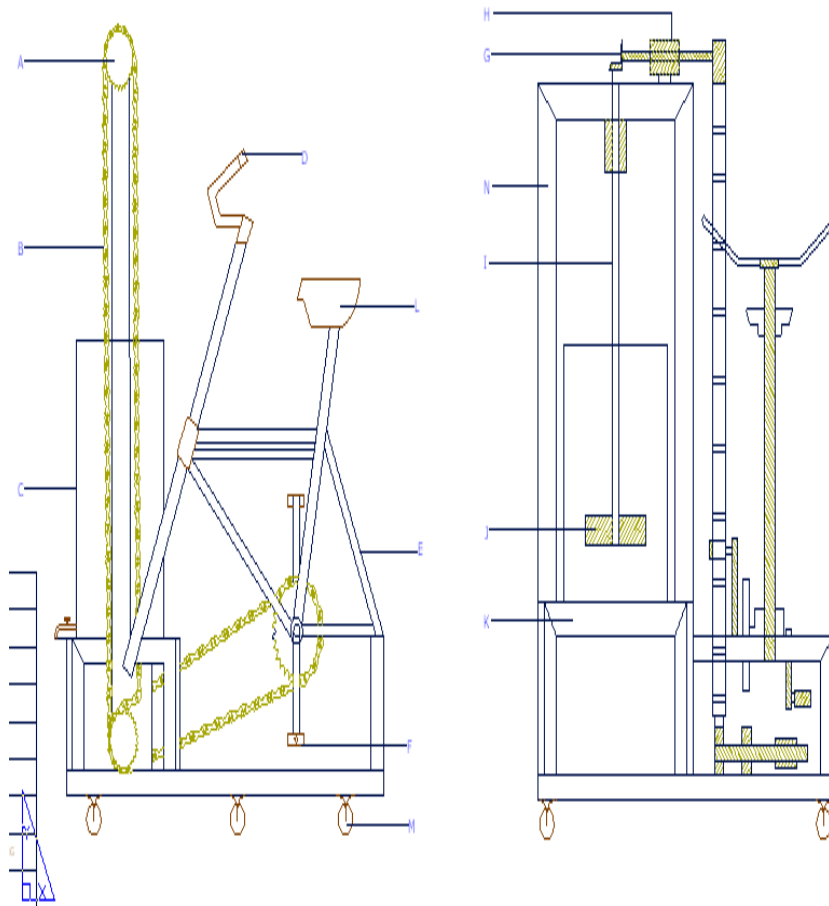
After the soap had solidified and cured, it was removed from the mold and cut into desired sizes and stamped with the University logo by the cutting and stamping machine as shown in Fig 2. The soap produced was fairly hard, form good lather and fair to the skin when used for washing.

**Table 1.** Quantity of materials used in soap making

<b>Material</b>	<b>Quantity</b>
Sodium Hydroxide	2kg
Palm kernel Oil	15litres
Sodium Sulphate	0.5kg
Soda lime	0.2kg
Soda ash	0.3kg
Water	5litres
Perfume	0.1litre

Soap production can be enhanced by making use of a locally fabricated pedal-powered soap mixer, which with little human effort makes the soap to properly mix and trace within few minutes. The mold made from high strength wood is simple, cost effective and can withstand the temperature of the soap solution without any adverse effect on its structure. The soap cutting and stamping machine makes the act of cutting and stamping easy, faster and neater than using ordinary knife and manual stamping machine.

The local soap making machine assembly is cost effective and can be a model for a one-shop soap factory for low income earners in developing countries.



A – Sprocket  
 B – Chain  
 C – Mixing vessel  
 D – Handle bar  
 E – Bicycle frame

F – Pedal  
 G – Bevel gear  
 H – Bearing housing  
 I – Impeller shaft  
 J – Turbine blade

K – Mixer support  
 L – Saddle seat  
 M – Rollers

**Fig. 1:** Pedal-powered Soap Mixer Schematic Diagram



**Fig. 2.** Soap Making, Cutting and Stamping Processes

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