DEVELOPMENT OF A BIO-BASED CONTAINER USING COCONUT (*Cococus nucifera*) FLOUR AND DETERMINATION OF ITS TECHNO-FUNCTIONAL PROPERTIES

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Abstract: Coconut (*Cocos nucifera)* is a dominant crop which is widely used for culinary purposes in household and industrial level. After extracting the coconut milk, the residue is most probably discarded. The present study is based on developing a biodegradable container using coconut residue flour. Coconut residue was subjected to blending, squeezing or pressing, drying at 110°C for 2 h and grinding to make a coconut flour. The obtained yield of coconut flour was 68% and white in color. Commercially available pectin was used as a binding agent mixing in the ratio 10:3 (coconut flour: pectin). The mixture was put into the mold and dried at 110°C for 3 h. The moisture content and permeability coefficient of biodegradable cup were 14.36% at 91°C and 5.17 x 10^{-9} cm^2Pa^{-1} s^{-1} respectively. In relation to visual observation of the Soil Burial Test, high biodegradation rate was observed and it completely biodegraded within 150 days period.

Keywords : Biodegradable, Coconut flour, Pectin, Permeability co-efficient , Soil Burial Test.

I. INTRODUCTION

Production of biodegradable containers has become a big trend now-a-days to prevent the problem arising due to the plastic crisis. Currently, in Sri Lanka we have a good trend of developing in the biodegradable packaging industry. This project focuses on a more practical approach for the development of biodegradable containers in Sri Lanka.

Coconut (*Cocos nucifera*) is one of the most available resources in Sri Lanka widely known as the tree of life due to its significant contribution to human life from all of its meat, water, husk, shell, wood, leaves, spikelet, etc. (Gunethilaka and Abeyrathne, 2008). Every part of the palm are utilized for the benefit of the humans and its fruit particularly provides important constituent of food which is indispensable in every household (Rana*et al.*, 2015). Coconut is one of the main ingredients in the Sri Lankan meal. After extracting the coconut milk from the coconut meat, the residue is discarded often as a waste and some are only used as an animal feed. But, still, there is no good application reported for the residue. Although it is a waste, still it has a high nutritional value such as high dietary fiber content, protein content etc. (Trinidad *et al.*, 2001). Ultimately, development of biodegradable containers from coconut residue by making coconut flour may have a potential to be a valuable application for sustainable development due to its biodegradable nature.

II. METHODOLOGY

The coconut residue (300g) was taken and ground gently using a grinder (Model MX-AC300,India) by adding little amount of water (100ml). After that, the ground sample was taken out and squeezed by hand. Then, it was dried for 2 h at 110°C in the oven (Model mammert854 Schwabach, Germany). The dried sample was ground again using a blender into flour. Flour was sifted by the strainer (0.5mm). Sifted flour was packed in a polyethylene bag and stored at the refrigerator. The yield of coconut flour was calculated with using below equation.

$$\text{Yield of coconut flour} = \frac{\text{Weight of dries coconut residue}}{\text{Weight of coconut residue}} \text{ x } 100\%$$

Commercially available pectin (3 g) (PectiPure^{TM}) was taken into the beaker and 50ml of hot water (80^{o}C) was added to it. The mixture was stirred properly until all pectin was dissolved without any clumps. Coconut flour (10 g) was taken into the container and pectin solution was added to it little by little. While adding pectin, flour and pectin were mixed by hand gently until a non-sticky dough was formed. The dough was put into the mold (Diameter 6cm, depth 4cm) and dried it at 110^{o}C for 3 h. The dried biodegradable cup was removed from the mold. Moisture content of the biodegradable cup was measured using moisture meter (MB 45-OHAUS). And the permeability co-efficiency of biodegradable cup was calculated using Frick's law and Henry's law (Mchugh*et al.*, 1993) according to below.

$$\text{Permeability co-efficient (P)} = \frac{Q \text{ x } d}{A \text{ x } t \text{ x } p}$$

P = Permeability co-efficient Q= Quantity of permeant
d= Thickness of material
A= Area of the material
t= Permeability time
p= partial vapor pressure of water

Biodegradability of the biodegradable container was tested using Soil Burial test .Owing to the test, Compost soil was taken into the five petri dishes. Five biodegradable cups were taken and buried in the compost soil giving same conditions (30±5^{o}C) for all samples. The biodegraded surface area of the sample was measured time to time.

III. RESULT AND DISCUSSION

Basic raw material for the production of the biodegradable container was coconut *(Cocus nusifera)* flour made out of coconut residue obtained after extracting coconut milk. It involved several major processing steps; blending, pressing, drying and grinding. Blending and pressing the coconut residue was useful to completely remove remaining coconut milk. Another important thing in pressing is, it is a defatting method and it helps to remove fat content from coconut residue. The most suitable temperature for drying coconut residue was 110^{o}C for 2 hours. If the temperature is increased above this level, brownish-yellow color discoloration and off-odors were obtained from the coconut residue. This may be due to various chemical reactions taking place such as denaturation of proteins and browning reactions. Flour obtained after grinding the dried coconut residue was white in color without any off odors. The calculated coconut flour yield was 68% from coconut residue.

Moisture analysis is very important to control the growth of microorganisms. Presence of high moisture content can affect deterioration by biological as well as chemical changes of the product. It widely affected the shelf-life of the product. According to the result of moisture meter, the biodegradable container had 14.36% moisture content when heated to 91^{o}C. Along with the Frick's low and Henry's low, Permeability co-efficient of developed biodegradable container was 5.17 x 10^{-9} $cm^2Pa^{-1}s^1$.

Table 1: Result for permeability co-efficient calculation

Q (cm^3)	**d (cm)**	**A (cm^2)**	**t (s)**	**p (Pa)**	**T (^{o}C)**
2	0.2	54.83	420	3360	26

$$P = \frac{2cm3 \text{ x } 0.2cm}{54.83cm2\ x\ 420sx\ 3360pa}$$

$$P = 5.17 \text{ x } 10^{-9}\ cm^2Pa^{-1}\ s^{-1}$$

According to the Biodegradability test (Soil Burial Test) continued for 150 days providing the same conditions (30±5°C) for all samples by measuring the biodegraded surface area of the sample, the biodegradability rate of the sample was very low up to 45 days. Afterwards, biodegradability was rapidly increased and it was taken 150 days for biodegradation completely.

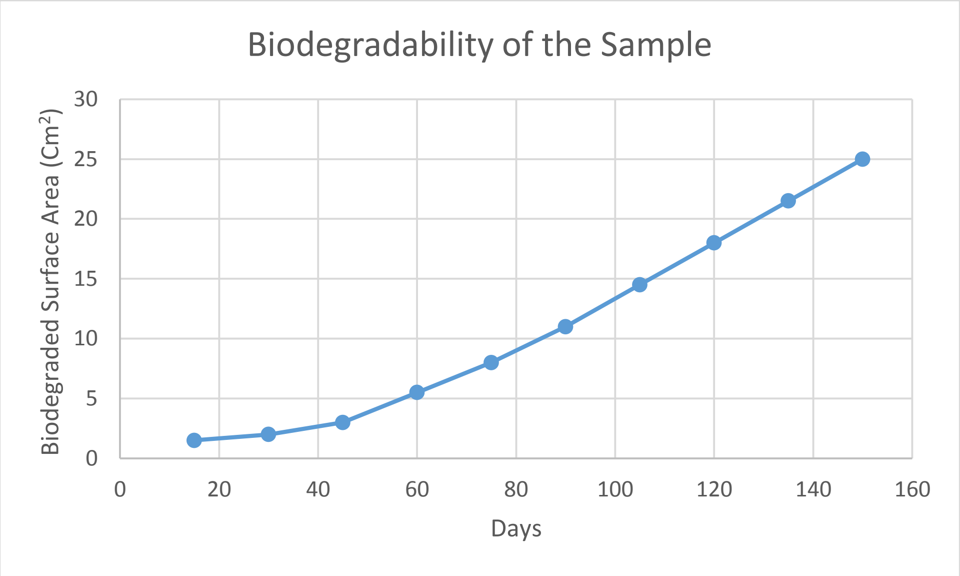

Figure 1: Biodegradation of Biodegradable container

IV. CONCLUSIONS

Coconut flour can be produced by subjecting coconut residue to blending, squeezing or pressing, drying at 110°C for 2 h and grinding. It should be stored at a dry place after packing in polyethylene bag. The obtained yield of coconut flour was 68% and white in color., The moisture content of biodegradable cup was 14.36% at 91°C and the permeability coefficient was 5.17 x 10^{-9} cm^2Pa^{-1} s^{-1} .. According to the visual observation of biodegradability test, it was completely biodegraded within five months period.

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