ISSN 2229-5518

# Coating of Foods with Plant Based Gum to Reduce Oil Absorption during Frying

O.P Weerasekera, S.B Navaratne

**Abstract**— This research discusses four edible plants named Durio zibethinus (Durian-seed), Abelmoschus esculentus (Okra-pod), Cinnamomum verum (Cinnamon-leaves), Neolitsea cassia (Dawul Kurundu-leaves) and gums were extracted using Water Extraction method. Extracted gums were coated on potato chips by dipping method. Then, they were fried in coconut oil and palm oil separately and measured the absorbed oil content using rapid method of oil extraction. The results were then analyzed using Factorial One Way ANOVA Design. From the statistical analysis, it can be concluded that there is a significant difference between the oil absorption in different coatings as well as in frying medium. Then, the four best samples which had less oil absorption were taken for sensory evaluation. The results were analyzed using Fread Mann Test. According to the results obtained, Okra pod gum was the most effective gum source, which reduced the oil absorption during frying (34%). However, from the sensory aspects, it was not the best source for coating of food items. It got lower points from the sensory evaluation in both cases. Second most effective gum source, which reduced the oil absorption during frying was Durian Seed gum. In coconut oil, as well as in palm oil, it had shown the second most reduction in oil absorption. The results of sensory evaluation proved that the best quality chips are the durian seed gum coated chips. When the cinnamon leaf gum and dawulkurundu leaf gum are concerned, they both did not show any remarkable reduction in oil absorption during frying. It may be due to releasing of gum to the oil. On the other hand, both gums might be heat unstable. Therefore, the two gums had to be rejected as both are not satisfying the main objective of this research.

**Index Terms.** *Abelmoschus esculentus* (Okra), *Cinnamomum verum* (Cinnamon), *Durio zibethinus* (Durian), *Neolitsea cassia* (Dawul Kurundu)

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## 1 INTRODUCTION

Fried foods have high caloric value, nutritious, have favorable taste, distinctive flavour, aroma and crunchy texture. However the oil consumption, especially saturated fat, is considered a major factor increasing health risks such as coronary heart disease (CHD), cancer, diabetes and hypertension, and even linked to increased causes of deaths. Moreover, scientists are now concerned about reducing oil content in fried foods in different ways. Several factors affect oil absorption in fried foods, including process conditions (temperature and residence time), initial moisture content of the product, raw material composition, slice thickness, pre-frying treatment, degree of starch gelatinization prior to frying, oil quality and coating.

Here, this research discusses one of the important factors, which can reduce the oil absorption during frying. That is the application of edible plant gum over food products prior to frying. It has been previously reported that the coating with cellular derivatives cause the formation of protective layer on the surface, which eventually decreases the oil uptake in the fried products. Currently, researchers are more interested in developing plant based coating formulations for consumer safety. A variety of plants and plant based materials are being investigated for their usefulness.

## 2 MATERIALS & METHODS

### 2.1 Materials

Glassware, viscometer, *Durio zibethinus* seeds, *Abelmoschus esculentus* pods, *Cinnamomum verum* leaves, *Neolitsea cassia* leaves, Coconut oil, Palm oil, Potatoes, Knife, deep fryer.

### 2.2 Methods

#### 2.2.1 Extraction of Plant Gums

Gum can be extracted using either solvent extraction method or water extraction method. From the solvent extraction method gum is extracted as a solid while in water extraction method gum is extracted as a liquid. In this research the gum was extracted using both two methods to measure the extractability with different extraction processes. However water extracted gum was used for coating during frying. *Durio zibethinus* seeds/ Sliced *Abelmoschus esculentus* / *Cinnamomum verum* leaves/ Neolitsea *cassia* leaves were crushed and then macerated in distilled water for 10 hours with intermittent stirring. The mucilage was filtered through a white muslin cloth to extract the gum and acetone was added to precipitate the extracted gum. The gum was then filtered under vacuum to remove acetone and dried in a desiccator.

Pod-water slurry, viscosity of 4000 centipoises was prepared for the coating prior frying.

#### 2.2.2 Coating of Gums

The method of application of the gum was important to the experiments because the application affects the thickness of the film, the evenness of the film, the ease of application and the texture of the film. Dipping was the method used for testing. Dipping involved, placing the product into the gum solution using tongs, leaving it in the solution for a few seconds, removing the product and letting the excess drip off. There is another method of applying gum is coating the gum over food product with the use of a brush.

After the gum extraction process potatoes were cut into chips with a unique size (0.5cm X 0.5cm X 5cm). Chips were then dipped in gums for 10 minutes. Control was prepared without coating any gum. Gum coated chips and the control were fried in coconut oil and palm oil separately. Here only the gum source and frying medium were differing and other things like potato variety, temperature of the fryer, residence time, slice thickness and quality of oil. Fried potato chips were separated into two and one was taken to analyze the absorbed oil content by using rapid method of fat analysis and free fatty acid content (FFA).Other samples were taken to carry out sensory evaluation to select the most preferable combination from the sensory aspects.

#### 2.2.3 Analysis of Absorbed total oil Content during Frying

2g of the sample was placed in a 100 ml beaker. Then 2 ml of 95 % ethyl alcohol and 10 ml of HCl which was prepared by mixing 25 ml of conc. HCl and 1 ml of water was added to it. The contents were mixed thoroughly and the beaker was placed on a water bath (70⁰C - 80 ⁰ C) and was stirred the contents for about 30 - 40 min frequently. After that beaker was removed from the water bath was cooled to at room temperature. Then 10 ml of EtOH was added to it and the mixer was then transferred into the majonnier flask. Beaker was washed with a 25 ml of diethyl ether in three portions and it was added to the flask.

The flask was Stoppard with a cork and was shaken vigorously for 1 min. 20 ml of pet Ether was added and shaken for 1 min again. Flask was kept undisturbed until upper ether layer is clear. Upper clear layer was then took and poured in to a clean dried and weighed flask. It was dried in a water bath at 80⁰C until a constant weight was obtained.

Three replicates were carried out for each sample. The results are shown in Table 1. Then the percentage of oil absorption was calculated. The results are shown in Table 2. Those results were analyzed using a statistical package (Factorial One Way ANOVA Design).

#### 2.2.4 Sensory Evaluation

Here, 25 numbers of untrained panelists were taken for the test. Panelists were given four samples with code number 254 (Potato chips coated with *Durio zibethinus* Seed Gum and fried in Coconut oil - A1), 328 (Potato chips coated with *Durio zibethinus* Seed Gum and fried in Palm oil - A2), 652 (Potato chips coated with *Abelmoschus esculentus* Pod um and fried in Coconut oil - B1) and 498 (Potato chips coated with *Abelmoschus esculentus* Pod um and fried in Palm oil - B2). Samples were selected based on the highest four values obtained from the oil absorption relative to the control. Seven point Hedonic Scale method was used to evaluate the best gum source. Panelists were advised to rank the given four samples according to their preference. Data were collected and sum was taken. Results were analyzed using Fread Mann test with Mini Tab package.

## 3 RESULTS & DISCUSSION

### 3.1 Amount of oil retained in Flasks

Gum coated potato chips were fried in coconut oil and palm oil separately. Then the absorbed oil was extracted by rapid method of oil extraction. Extracted oil with beakers was weighed using analytical balance. Net weight of extracted oil is given in table 1.

Table 1: Weights of the oil retained in the flasks

| Frying Medium | Replicate No. | *Durio zibethinus* Seed Gum Coated chips | *Abelmoschus esculentus* Gum Coated chips | *Cinnamomum verum* Leaf Gum Coated chips | *Neolitsea cassia* Leaf Gum Coated chips | Control |
|---|---|---|---|---|---|---|
| With Coconut Oil | R1 | 8.5% | 7.3% | 9.9% | 10.2% | 11.4% |
| | R2 | 8.3% | 7.5% | 9.7% | 10.0% | 11.6% |
| | R3 | 8.4% | 7.2% | 9.8% | 10.3% | 11.3% |
| Mean | | 8.4% | 7.3% | 9.8% | 10.2% | 11.4% |
| With Palm Oil | R1 | 9.3% | 8.8% | 11.7% | 10.9% | 13.5% |
| | R2 | 9.4% | 8.5% | 11.5% | 10.8% | 13.2% |
| | R3 | 9.6% | 8.7% | 11.6% | 10.9% | 13.4% |
| Mean | | 9.4% | 8.8% | 11.6% | 10.9% | 13.4% |

According to Table 1, we can clearly see that *Abelmoschus esculentus* gum coated chips have less amount of oil retained in flasks compared to other treatments. Moreover, control has the highest oil weight.

### 3.2 Percentage of oil Absorption

From the values obtained, percentage of oil absorptions were calculated using following equation.

$$\text{Percentage of Oil absorption} = \frac{\text{Weight of the oil absorbed} \times 100}{\text{Weight of the sample}}$$

Summary of the results obtained as percentage of Oil Absorption is shown in Table 2.

Table 2: Percentage of Oil Absorption

| Frying Medium | Replicate No. | *Durio zibethinus* Seed Gum Coated chips | *Abelmoschus esculentus* Gum Coated chips | *Cinnamomun verum* Leaf Gum Coated chips | *Neolitsea cassia* Leaf Gum Coated chips | Control |
|---|---|---|---|---|---|---|
| With Coconut Oil | R1 | 8.5% | 7.3% | 9.9% | 10.2% | 11.4% |
| | R2 | 8.3% | 7.5% | 9.7% | 10.0% | 11.6% |
| | R3 | 8.4% | 7.2% | 9.8% | 10.3% | 11.3% |
| Mean | | **8.4%** | **7.3%** | **9.8%** | **10.2%** | **11.4%** |
| With Palm Oil | R1 | 9.3% | 8.8% | 11.7% | 10.9% | 13.5% |
| | R2 | 9.4% | 8.5% | 11.5% | 10.8% | 13.2% |
| | R3 | 9.6% | 8.7% | 11.6% | 10.9% | 13.4% |
| Mean | | **9.4%** | **8.8%** | **11.6%** | **10.9%** | **13.4%** |

From the calculated values in Table 2, we can see that the oil absorption is less in *Abelmoschus esculentus* compared to other treatments. However, Factorial One-way ANOVA was done to determine if there is significant difference between plant gums as well as frying medium.

Statistical summary obtained for the factorial one way ANOVA indicates statistical significance for the major factor absorptive agent as well as the major factor frying medium under 95% (CI). Moreover, experimentation provides statistical significance for the interaction as well. Therefore, this gives possible indication in variation in the major coating agents via response variable oil absorption. Following the ANOVA procedure data were subjected to mean separation, were the Dunnetts test was conducted to evaluate the variability with control according to the evaluation all treatments show negative absorption with respect to the control, graph could be elaborated as the interaction plot (Figure 1). (Treatment1 = Control, Treatment 2 = *Durio zibethinus*, Treatment 3 = *Abelmoschus esculentus* , Treatment 4 = *Cinnamomum verum* Leaves, Treatment 5 = *Neolitsea cassia* Leaves and Oil Type 1 = Coconut oil, Oil Type 2 = Palm Oil)

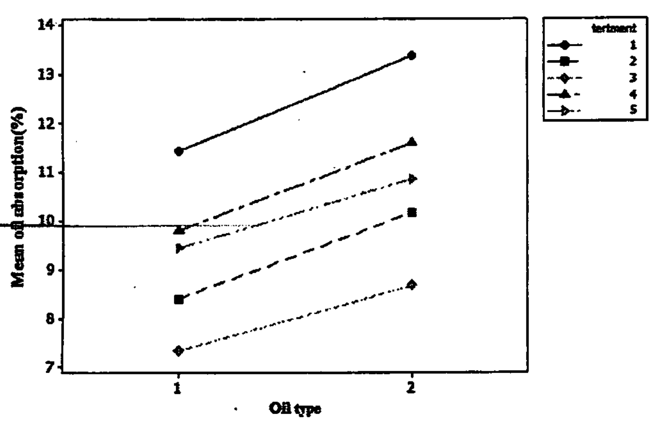


**Figure 1: Interaction Plot of Plant Gums and Type of Oil**

According to Figure 1, we can clearly see the minimum oil absorption shown in *Abelmoschus esculentus* pod gum coated chip, followed by *Durio zibethinus* seed gum, *Neolitsea cassia* leaf gum and finally *Cinnamomum verum* leaf gum coated chips compared to the Control. Also Coconut oil has less oil absorption than Palm oil in all cases. In nature, some edible plant gums are heat resistant and some are heat liable. In this research we can conclude that *Abelmoschus esculentus* pod gum and *Durio zibethinus* seed gum are more heat stable than *Cinnamomum verum* and *Neolitsea cassia* leaf gum. Therefore the oil absorption is higher in both *Cinnamomum verum* and *Neolitsea cassia* leaf gum coated chips.

Since the properties of the surface of the food are most important for fat uptake, the application of a coating is a promising route. This coating can be thin and 'invisible' (Gennadios, Hanna, & Kurth, 1997), or can be thick like a batter. There are many options available to reduce fat uptake by application of coatings or batters. The mechanism of action is usually not clarified, though sometimes the functionality is endorsed to a specific property. Often mentioned properties of coatings in relation to fat uptake are low moisture content, low moisture permeability, thermo gelling or cross linked. All properties are aimed at reducing moisture loss and/or modification of the surface structure formed upon frying.

Considering the importance of the condensation mechanism and the properties of the crust pores (which are a food or coating property), only a minor degree of control on fat uptake can be expected by modification of the frying fat. However, assuming the applicability of the capillary mechanism, the viscosity and/or wetting characteristics of the oil could affect fat uptake. Even though theory predicts that the viscosity of hot oil affects oil uptake, it will not be easy to control this parameter. A high oil viscosity, or a steeply increasing oil viscosity upon cooling (especially in the presence of hard fats), will decrease oil uptake because oil flow is hampered especially in the small pores. However, the same will lead to less easy drainage or shaking of the oil from the food after it is taken out of the frying oil. In principle the total amount of oil adhering to the food determines the maximum amount of oil that can enter the pores. This suggests that easy drainage can be beneficial. Tsenget al. (1996) argued that oil uptake in tortilla chips increases upon oil degradation, because of the accompanying increase in oil viscosity.

### 3.3 Reduction of Oil Absorption

From the values obtained in Table 2, percentages of oil absorption relative to the control were calculated using the following equation. This calculation was done in order to select best four treatments which reduce oil absorption during frying for the sensory evaluation.

Summary of the results obtained as percentage of Reduction of Oil Absorption is shown in Figure 2.

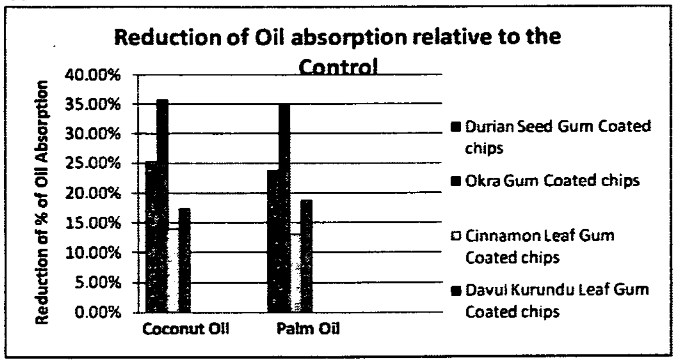


**Figure 2: Reduction of Oil absorption relative to the Control**

According to the results in Figure 2, *Durio zibethinus* seed gum and *Abelmoschus esculentus* pod gum gave the best results. Therefore both *Durio zibethinus* seed gum and *Abelmoschus esculentus* pod gum coated potato chips with coconut oil and with palm oil were taken for the sensory evaluation.

### 3.3 Organoleptic properties of Fried potato chips

Based on the results obtained from the Figure 2, four samples were taken for the sensory analysis. They are potato chips coated with *Durio zibethinus* seed gum and fried in coconut oil (A1), potato chips coated with *Durio zibethinus* seed gum and fried with palm oil (A2), potato chips coated with *Abelmoschus esculentus* pod gum and fried with coconut oil (B1) and finally, potato chips coated with coated with *Abelmoschus esculentus* pod gum and fried with palm oil (B). Seven Point Hedonic Scale was the method used to rank the chips according preference. Summary of the results are shown in Table 3. Results were analyzed using Fread Mann test with Mini Tab package.

**Table 3: Summery of Sensory Evaluation results (panelist responses)**

| Parameter | A1 | A2 | B1 | B2 |
|---|---|---|---|---|
| *Color* | 164 | 160 | 68 | 75 |
| *Taste* | 158 | 132 | 80 | 55 |
| *Odor* | 167 | 136 | 100 | 70 |
| *Texture* | 164 | 139 | 81 | 57 |
| *Overall acceptability* | 164 | 140 | 82 | 65 |

According to the Table 3, highest ranks were obtained by the *Durio zibethinus* seed gum coated chips and lowest ranks were obtained by *Abelmoschus esculentus* pod gum coated chips for the Color attribute. A1 and A2 were developed pleasant brownish yellow color during frying. However B1 and B2 were developed unpleasant color as the product looked like soggy during frying.

When we consider about the flavor and odor, highest ranks were obtained by A1 and A2 and lowest ranks were obtained by B1 and B2. Further, chips fried with coconut oil were obtained higher ranks than those of fried with palm oil. The reason may be due to the unique flavor and odor of the coconut oil.

According to the results obtained for texture, it seems *Abelmoschus esculentus* pod gum coated chips are worst. Panelists were preferred *Durio zibethinus* seed gum coated chips have the best texture among four treatments. With most heat-resistant (e.g. cross linked) water barrier films evaporation may be too much limited, which will lead to a more soggy fried food. *Abelmoschus esculentus* pod gum is more heat resistant than *Durio zibethinus* seed gum. Therefore the chips coated with *Abelmoschus esculentus* gum have soggy texture.

Therefore overall acceptability received by the *Durio zibethinus* seed gum coated chips. These results were then analyzed using Fread Mann test with Mini Tab package. According to the statistical analysis we can conclude that in all cases estimated median is higher than grand median in *Durio zibethinus* seed gum coated chips (Treatment 1 & 4) also estimated median is lower than grand median in *Abelmoschus esculentus* pod gum coated chips (Treatment 2& 3). Further analyzing the results we can select *Durio zibethinus* seed gum coated chips fried in coconut oil as the best treatment followed by *Durio zibethinus* seed gum coated chips fried in palm oil, *Abelmoschus esculentus* pod gum coated chips fried in coconut oil and worst treatment is the *Abelmoschus esculentus* pod gum coated chips fried in palm oil. This is clearly shown in Figure 3.

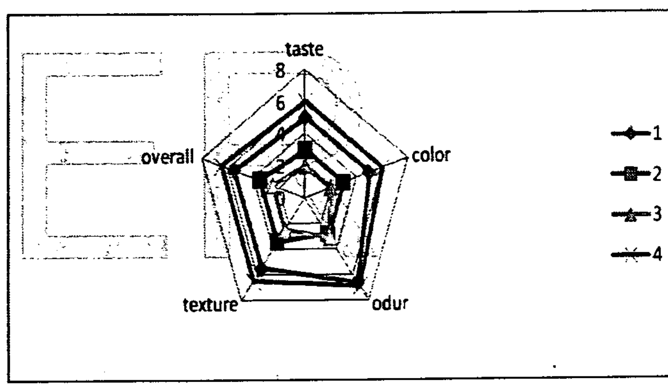


**Figure 3: Summery of Sensory Evaluation (Summery obtained from Fred Mann Test)**

The solubility in water and acid of polysaccharide films is advantageous in situations where the film is consumed with the product, causing little change in sensory properties of food. Here, *Abelmoschus esculentus* gum changed the sensory properties of chips and it was not preferred by the panelists.

## 4 CONCLUSION

From the statistical analysis, we can conclude that there is a significant difference between selected edible plant gums as well as the frying medium. According to the results obtained, *Abelmoschus esculentus* pod gum is the most effective gum source, which reduced the oil absorption during frying. However, from the sensory aspects, it is not the best source for coating of food items. It got lower estimated median from the sensory evaluation in both cases. It has a soggy like appearance as well as the texture; and, it does not have a crispy texture. Second most effective gum source, which reduces the oil absorption during frying is *Durio zibethinus* Seed gum. With coconut oil as well as in palm oil, it shows the second less oil absorption. The results of sensory evaluation proved that the best quality chips are the *Durio zibethinus* seed gum coated chips. Overall acceptability is for the *Durio zibethinus* seed gum coated chips.

When one considers the *Cinnamomum verum* leaf gum and *Neolitsea cassia* leaf gum, they both did not show any remarkable reduction of oil absorption during frying. It may be due to releasing of gum to the oil. On the other hand, both gums might be heat unstable. Therefore, the two gums have to be rejected as both are not satisfying our main objectives of this research.

In all cases the oil absorption is much higher in the chips fried in palm oil compared to the chips fried in coconut oil. Palm oil consists of long chain fatty acids. It has the highest amount of Oleic acid.

## 4 REFERENCES


- Abbasi, K. S., Masud, T., Ali, S., Mahmood, T., Hussain, A., Liaquat, M., & Jahangir, M. (2015). Quality of Potato Chips as Influenced by Aloe Vera Coating. *Journal of Food and Nutrition Research, 3*(3), 157-161.
- Amid, B., Mirhosseini, H., & Kostadinović, S. (2012). Chemical composition and molecular structure of polysaccharide-protein biopolymer from *Durio zibethinus* seed: extraction and purification process. Chem Cent J, 6, 117.
- Dana, D., & Saguy, I. S. (2006). Review: mechanism of oil uptake during deep-fat frying and the surfactant effect-theory and myth. Advances in Colloid and Interface Science, 128, 267-272.
- Garcıa, M. A., Ferrero, C., Bertola, N., Martino, M., & Zaritzky, N. (2002). Edible coatings from cellulose derivatives to reduce oil uptake in fried products. Innovative Food Science & Emerging Technologies, 3(4), 391-397.
- Gennadios, A., Hanna, M. A., & Kurth, L. B. (1997). Application of edible coatings on meats, poultry and seafoods: a review. *LWT-Food Science and Technology, 30*(4), 337-350.
- Krokida, M. K., Oreopoulou, V., & Maroulis, Z. B. (2000). Water loss and oil uptake as a function of frying time. *Journal of Food Engineering, 44*(1), 39-46.
- PINTHUS, E. J., WEINBERG, P., & SAGUY, I. S. (1993). Criterion for oil uptake during deep-fat frying. *Journal of Food Science, 58*(1), 204-205.
- Rimac-Brnčić, S., Lelas, V., Rade, D., & Šimundić, B. (2004). Decreasing of oil absorption in potato strips during deep fat frying. Journal of Food Engineering, 64(2), 237-241.
- Saenz, W., (1960). Some Applications of Okra in the Food Industries. In Proceedings-FLORIDA STATE HORTICULTURAL SOCIETY (Vol. 108, pp. 201-203). FLORIDA STATE HORTICULTURAL SOCIETY.
- Tavakoli, N., Teimouri, R., & Hamishehkar, H. (2007). Characterization and evaluation of okra gum as a tablet binder. Jundushapur Journal of Natural Pharmaceutical Products, 3(1), 33-38.
- Tseng, Y. C., Moreira, R., & Sun, X. (1996). Total frying-use time effects on soybean-oil deterioration and on tortilla chip quality. *International journal of food science & technology, 31*(3), 287-294.



- *Author is O.P Weerasekera, currently pursuing Masters Degree in the Department of Food Science & Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka. E-mail: oushadhee@gmail.com*
- *Co-Author is S.B Navaratne, Senior Lecturer, Department of Food Science & Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka. E-mail: sbnava1234@yahoo.com*