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EFFECT OF HYDROCOLLOIDS COATING ON THE QUALITY ATTRIBUTES OF TARO CHIPS

Dalia Elsa John and Bahadur Singh Hathan*
Department of Food Engineering and Technology, Sant Longowal Institute of Engineering and Technology
Longowal, Punjab, India

*Corresponding Author: bshathan@yahoo.com

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ABSTRACT

The effect of different hydrocolloids on reduction of oil absorption and other quality parameters of taro chips during deep fat frying were investigated. Before conducting these experiments, the process of taro chips preparation was optimized for chips thickness, frying oil temperature and frying time by Response Surface Methodology. The optimum conditions for uncoated chips for chips thickness, frying oil temperature were 1.5 mm, 170°C and 3 minutes, respectively. The slices of 1.5 mm thickness were blanched in 0.5% $CaCl_2$ at 80°C for 5 minutes followed by dipping in aqueous solution of hydrocolloids (pectin, guar gum and methyl cellulose) having concentration from 0.5-1.5%. The coated chips partially dried at 60°C in a tray dryer to get a final moisture content of 40% (wet basis) followed by deep frying in refined sunflower oil at 170°C for 3 min. The coated and uncoated chips were analyzed for different quality parameters viz. percentage coating pick-up, moisture content, decrease in fat uptake, and sensory quality. Among different gums that used in this study, Methyl cellulose coating with 1.5% concentration resulted in better quality chips as compared to pectin and guar gum coating having highest potential to reduce the oil absorption and better sensory quality.

Keywords: Hydrocolloids, Taro chips, quality attributes, Oil absorption, sensory quality

INTRODUCTION

Taro (*Colocasia esculenta*) is a root vegetable found primarily in the tropical and sub-tropical regions of the world. It is a member of the Arum Family (*Aracea*) and is a tropical tuber crop largely produced for its underground corms. This plant is known with several names, including dasheen, eddoe, cocoyam, or tannia (Kaushal et al., 2012). Taro is rich in gums (mucilage) and has been reported to have 70-80% starch with small granules (diameter between 1.4 and 5 micrometer). Taro's digestibility, because of small starch grains, and its hypoallergenic qualities are other qualities that make it a unique product. Nutritionally, taro has broader complement of vitamins and nutrients than other tubers. The different varieties of taro available in the world include *Cyrtosperma chamissonis* (giant swamp taro), *Xanthosoma sagittifolium, Colocasia esculenta* (taro) and *Alocasia macrorrhiza* (giant taro) (Kaushal and Sharma, 2013). The nutritionally potent corms constitute the main edible part of the plant. The taro crop is consumed in various ways in different countries prepared in the same way as potato and sweet potato. Taro consumption has been affected by the presence of acridity factors, which cause sharp irritation and burning sensation in the throat and mouth on ingestion. The acridity factor can be reduced by peeling, grating, soaking and fermentation operations during processing (Kaushal et al., 2013).

The world snack food market is currently expanding rapidly. A large part of this market consists of chips or fried products using starch-based raw materials (roots, tubers, bananas and plantains). With the rise of urban centers and growing urban populations demand for ready-to-eat affordable food is increasing. Nowadays the demand for low calorie foods has risen due to the health cautiousness among the people.

Frying is one of the oldest and most popular cooking methods in existence (Amany et al., 2012). Under the established conditions of fried material's natural properties and corresponding sample handling, frying can involve all of the components to participate in a series of physical and chemical alterations (Zhang et al., 2012). Frying involves several chemical and physical changes including starch gelatinization, protein denaturation, water vaporization, and crust formation as well as nutritional changes. Frying of any product improves its taste making it juicy and crisp due to the light outer crust formed during the frying process. The distribution and the amount of oil absorbed are affected by the oil quality and composition, frying temperature and time, product composition, moisture content, shape, porosity, pre-frying treatment, surface treatments, initial interfacial tension and crust size (Pinthus and Saguy, 1993).

The consumer's preference for low fat and fat-free fried foods is the need of the hour and therefore various researches are being carried out for ways to minimize the oil uptake in fried foods still retaining the desirable texture and flavor of the final product. The use of fat replacers such as fat mimetics, low calorie fats and fat substitutes are used in various countries. Fat mimetics are substances that imitate organoleptic or physical properties of triglycerides but which cannot replace fat on a one-to-one, gram-for-gram basis. This implies that all these techniques are aiming to reduce the fat uptake in drying but these aspects are not fully achieved by these techniques but still research is going on to find out the effect of these fat replacers and fat mimetics in fried foods. To make such product more acceptable to the health cautious consumers, the oil uptake should be reduced either by use of fat replacers such as fat mimetics, low calorie fats and fat substitutes. Several other approaches may include modification of the frying techniques, pre-processing of the chips (blanching, drying, and freezing), employing desirable frying practices/ procedures and finally the use of coatings and batters onto the product before frying. The use of hydrocolloids in many food formulations have been reported to improve the quality attributes and shelf-life of the fried foods (Saha and Bhattacharya, 2010). Hydrocolloids have been and are widely used in the food industry in the last few decades. The various hydrocolloids used in food industry are pectin, sodium alginate, powdered cellulose and corn zein etc.

The objectives of present study was to determine the effect of coating with edible agents such as pectin (P), guar gum (GG) and methyl cellulose (MC) on various quality attributes of taro chips and sensory quality of the coated taro chips. These coatings were used to reduce fat uptake in chips as the application of a coating is a promising route to reduce oil content (Mellema, 2003). Moreover, these gums are widely used in many food formulations to improve quality attributes and shelf-life (Saha and Bhattacharya 2010).

MATERIALS AND METHODS

MATERIALS

Raw taro (*Colocasia esculenta*) corms of commercial variety were physically examined to ensure they were disease-free and then stored in a cool (10°C) temperature and used within 24 h. The hydrocolloids used in the investigation were pectin (P), guar gum (GG) and methyl cellulose (MC).

TARO CHIPS PROCESSING

The fresh taro corms were washed peeled manually using a sterile stainless steel kitchen knife and trimmed off all undesirable parts. They were then washed in water at 33°C for 3 minutes in order to remove surface starch and other unwanted extraneous materials (Ikpeme-Emmanuel et al., 2009). The water was drained and the taro was sliced to uniform thickness using a manual slicer. The slices were washed in cold water to remove surface starch and blotted using paper towel. The taro slices were then pretreated with 0.5% $CaCl_2$ at 80°C for 5min to remove residual surface starch, and deactivate enzyme. It was then drained and washed to remove free starch.

Before coating the chips with hydrocolloids, the process of taro chips preparation was optimized for chips thickness, frying oil temperature and frying time by Response Surface Methodology. The optimum conditions for uncoated chips for chips thickness, frying oil temperature were 1.5 mm, 170°C and 3 minutes, respectively.

The surface of the pretreated taro slices having 1.5 mm thickness were blotted with a paper towel followed by immersion in 0.5, 1.0 or 1.5 g hydrocolloids (pectin, guar gum and methyl cellulose)/100 ml distilled water at 37 °C for 2 min. Then, all pieces were drained and partially dried at 60°C in a tray dryer to get final moisture content of 40% (w.b.). The partially dehydrated chips were deep fried in sunflower oil at 170°C temperature for 3 minutes. The fried chips were drained of excess oil by placing on tissue paper (3-4 min) and cooled to room temperature (25±1°C) before performing any analysis.

ANALYSIS OF SAMPLE

COATING PICK-UP CALCULATIONS

The amount of hydrocolloid adhered onto the taro slices during the coating process was represented by the term coating pick-up. It can be formulated from the following (Parinyasiri *et al.*, 1991);

$$\%\ \text{Coating pick up} = \frac{(C - I)}{I} \times 100$$

where C is the weight of raw coated taro slices (g) and I is the initial weight of raw non-coated taro slices (g)

WATER CONTENT (WC)

Approximately 5 g of the ground taro chips was oven dried at 102 ± 3 °C until three or four successive constant weight readings were obtained. The tests were carried out in triplicate.

FAT CONTENT (FC)

The fat contents were measured after frying the coated samples. The purpose of these measurements was to observe any changes in product composition due to coating (Susanne and Gauri, 2002).

FAT REDUCTION DUE TO COATING

This can be calculated by the method suggested by Garmakhany *et al.* (2012);

$$\text{Fat reduction due to coating} = \frac{\text{LC}(\text{after coating})\text{-LC}(\text{before coatng})}{\text{LC}(\text{before coatng})} \times 100$$

Where, LC-coated and LC-uncoated are the fat contents of the coated and uncoated samples, respectively.

FRYING YIELD CALCULATIONS

The percentage of frying yield of the fried taro chips was obtained and calculated from the following equation (Parinyasiri *et al.*, 1991);

$$\%\ \text{Frying yield} = \frac{(CW)}{C} \times 100$$

where is the CW cooked weight of coated taro chips (g) and C is the weight of non-cooked coated taro chips(g).

SENSORY EVALUATION

Coded samples were presented to a panel of ten members to carry out the sensory analysis of the fried chips. Nine point hedonic scale was used for sensory evaluation of chips. The scores received by each sample were then averaged and compared with the average score received by other samples in the series (Ranganna, 1999). The sensory quality of the chips was evaluated on the basis of overall acceptability.

RESULTS AND DISCUSSION

The effect of various hydrocolloids coatings having different concentrations on various quality parameters is discussed below:

EFFECT OF COATING MATERIAL AND CONCENTRATION ON COATING PICK-UP OF TARO CHIPS

It can be observed from Table 1 that 1.5% guar gum has the highest amount of coating pick-up ($p<0.05$) among the various treatments given to taro chips. This may be due to ability of thick gel formation. Pectin and methyl cellulose showed a comparatively lower and similar coating pick-up when applied to taro chips. Further, higher the concentration of the solution, more coating pick-up has been observed ($p<0.05$). This might be because the coating pick up is generally directly correlated with batter viscosity, that is, as viscosity increases, more batter remains on the sample. Due to viscosity building effects of gums, the guar gum coating gave better adherence to the surface of the taro slices as compared to Pectin and methyl cellulose. Similar observations were reported by Cunningham and Tiede (1981) and Dogan *et al.* (2005a, 2005b).

EFFECT OF COATING MATERIAL AND CONCENTRATION ON FAT UPTAKE OF TARO CHIPS

From Table 1 it was observed that coating the blanched taro slices with each hydrocolloid produced a significant reduction in oil absorption, as reflected by the decrease in fat uptake due to coating compared to the control treatment. The coated hydrocolloids reduce the fat uptake by forming a protective barrier layer on the food surfaces blocking excess oil to enter from the frying medium. Pahade and Sakhale (2012) reported that comparatively less mass transfer due to coating with the hydrocolloids leads to decreased fat content of the fried foods. Among the different hydrocolloids, the chips coated with 0.5% pectin led to highest fat content probably due to the less adhesion onto the taro slices when immersed in the coating solutions. The lowest fat content was observed for 1.5% methyl cellulose. Further with increase of methyl cellulose concentrations, there was a significant reduction in fat absorption (Hung et al., 2011). Mellema, 2003 reported that the thermal gelation or cross linking properties of gums promote the formation of a small amount of wide punctures with low capillary pressures, which resulted in less oil entrance to the pores. Among all hydrocolloids coated, MC provided the lowest oil uptake during frying. Mallikarjunan *et al.* (1997) reported that the methyl cellulose viscosity increases dramatically with increasing temperatures to the point where the solution gels. This gel layer might have controlled the transfer of moisture and fat between the product and the frying medium. The most interesting feature for the application of MC in thermally treated foods, particularly in fried products, is the reversible thermal gelation capability in aqueous systems, which is widely utilized to reduce oil absorption during the frying of various foods, such as meat, poultry, starchy foods, doughs, etc. (Rimac-Brncic *et. al.*, 2004).

EFFECT OF COATING MATERIAL ON THE FRYING YIELD OF TARO CHIPS

Higher frying yield were observed for taro chips coated with 0.5% pectin followed by the control sample having frying yield value as 38.48%. Guar gum and MC showed lower frying yields for fried taro chips. The percent frying yield represents the mass loss during frying and is calculated from mass before and after frying. Higher the frying yield, greater will be the mass loss that occurred during the frying process. Hence it is clear from the present study that with the application of hydrocolloids, the mass loss has reduced for deep-fried taro chips. The reason for lower mass loss could be attributed to the moisture retention properties of the edible films. In addition, the edible coatings acted as protective layers reducing material loss from the surface to the frying medium. The oil reduction capability of the coatings was probably due to their abilities to form a thermal gel during frying (Pranoto et al., 2009). Mallikarjunan *et al.* (1997) also reported that mashed potato balls coated with gums like corn zein, hydroxypropyl methyl cellulose or methyl cellulose film-forming solution reduced mass loss significantly and had approximately 40% lower mass loss than control samples.

SENSORY EVALUATION

Sensory scores on hedonic scale for overall acceptability of the fried taro chips are shown in Table 1. The sensory evaluations of taro chips were affected by the hydrocolloids coating ($p <0.05$). The overall acceptability score of chips coated with pectin were minimum and maximum for chips coated with methyl cellulose. Further, with increase of concentration of methyl cellulose, an increase in overall acceptability score was observed. This might be due to low oil uptake and crispness provided by the coating. Alimi et al., 2013 also reported that the coatings with hydrocolloids led to significant reduction in oil absorption and improvement in the crispness of the final fried product (Alimi et al., 2013). The overall acceptability scores of chips coated with 1.5% methyl cellulose were comparable with the uncoated chips. The use of hydrocolloids was found to improve the texture and moisture retention in cake batters and dough, to increase the volume and shelf life of cereal foods by limiting starch retrogradation, improves their eating quality and appearance (Kotoki and Deka, 2010).

Table 1- Effect of coating layer with hydrocolloids on quality attribute and sensory quality of Taro chips

Treatment	Coating pick-up (%w.b)	Fat content (%w.b)	Decrease in fat uptake due to coating (%w.b)	% Frying yield	Overall Acceptability
Control	-	35.12±0.046	-	38.48±0.02	8±1.231
0.5% Pectin	2.36±0.182	30.46±0.192	12.54±0.255	50.43801±0.01	7±0.092
1.0% Pectin	3.13±0.121	26.38±0.142	24.37±0.150	27.96627±0.01	6±1.723
1.5% Pectin	3.45±0.251	25.76±0.18	26.35±0.191	27.41299±0.03	5±0.418
0.5% Guar gum	4.59±0.296	23.33±0.075	33.25±0.199	26.56505±0.02	7±1.192
1.0% Guar gum	5.07±0.077	24.43±0.186	29.69±0.292	32.78787±0.01	7±0.610
1.5% Guar gum	6.05±0.045	25.20±0.135	28.2±0.131	27.65331±0.03	8±0.213
0.5% Methyl cellulose	2.32±0.179	19.25±0.095	45.07±0.041	17.77348±0.03	7±1.181
1.0% Methyl cellulose	3.20±0.114	17.05±0.15	51.31±0.207	28.78079±0.02	8±0.074
1.5% Methyl cellulose	3.38±0.209	16.54±0.145	52.36±0.23	22.86162±0.01	8±1.377

CONCLUSION

Among all the hydrocolloids studied at different levels for preparation of Taro chips, it can be concluded that taro slices pretreated with 0.5% calcium chloride and coated with 1.5% MC were found to obtain taro chips of good quality attributes and sensorial quality characteristics. Moreover, with the application of hydrocolloids, the frying yield of the chips has increased due to less moisture loss during frying. Thus, Taro chips with reduced oil and low calorie content with improved overall acceptability can be prepared as an alternative to the most popular potato chips, in order to meet the demand of health cautious consumers.

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