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RESEARCH ARTICLE

Minimizing oil uptake in lotus root chips: leveraging hydrocolloids for improved quality

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ABSTRACT

The present study was aimed to assess the influence of hydrocolloids (pectin and gelatin) to reduce the oil absorption in fried lotus root chips. Lotus root was hand peeled and sliced into 0.2 cm thickness. Then blanched in calcium chloride 0.5g/100ml water at 85^{0}C for 30 seconds followed by immersion in different concentration of gelatin and of pectin in 100ml of water at 37^{0}C for 2 minutes. The coated chips were fried at 180^{0}C in groundnut oil till the surface becomes golden brown. The lotus root chips prepared using different concentration of pectin and gelatin coating was evaluated for its moisture, lipid and texture profile. The moisture content increased with increase in pectin and gelatin concentration. Pectin and gelatin significantly reduced the oil absorption with increase in concentration. Lotus root chips prepared using 1g of pectin/ 100ml of water was rated (8.24) most acceptable by semi-trained panel members on a nine-point hedonic scale. The hardness of the treated chips ranged between 832.463±74.54 to 845.541±78.45. the colour analysis L*, a* and b* ranged from 48.48±5.80 to 46.81±0.33, 1.29±0.52 to 1.43±0.53 and 15.25±1.44 to 12.98±3.43 respectively. Pectin and gelatin can be used to reduce the oil absorption in fried products.

Keywords: Lotus root chips, pectin, gelatin and hydrocolloids.

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INTRODUCTION

In China, India, Japan, and other regions of South-East Asia, lotus plants (*Nelumbo nucifera*) are common aquatic herbs. The seeds, blooms, stem, and rhizome of the lotus plant are discovered to have a variety of uses, including both as a food source and in traditional medical practises like Ayurveda and Traditional Chinese Medicine. After being roasted, lotus rhizomes (roots) are typically eaten or used as a vegetable to make curries, spicy pickles, etc. (Yodkraisri, 2012). Deep fat fry is a broadly involved technique in preparation of food. Submerging food pieces during hot deep-fat fry aids in sealing the surface and retains the flavours and juices. Water present in the food undergoes partial evaporation due to high temperature of oil. Even-though fried food has high fat content it is still popular among the consumers. As a multifunctional additive, hydrocolloids are used in many food products to improve the emulsion stability, viscosity, and water binding capacity. Deep-fat frying is a dry cooking method in which the oil or fat migrates into the food, where it imparts nutrients and flavour that make it appetising. Fat reacts with both the protein and the carbohydrate components of the diet during this process to produce the desired sensory qualities. Although

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frying can be done at temperatures between 140°C and 190°C, 170°C to 190°C is the most typical range. High heat transfer rates, quick cooking, browning, and the development of texture and flavour are all caused by these circumstances. One of the key aspects of deep-fat frying is oil absorption. The food business and customers have a keen interest in producing fried goods of a high and consistent quality with the right amount of oil (Archana et al., 2016; Salehi, 2019). Hydrocolloids are frequently employed in the food business for a number of functions, including lowering the rate at which food products absorb oil. Foods that have absorbed oil may end up being greasy and oily, which may not be as appealing to consumers. The amount of oil absorbed while cooking can be decreased by employing hydrocolloids, which could result in a lighter and less oily finished product. Polysaccharides and proteins collectively referred to as hydrocolloids have the capacity to gel with water (Wüstenberg, 2015). Edible coating was used as one of the techniques to change the surface of the product. Since frying is primarily a surface phenomenon, modifying the product surface has been shown to be the most effective method for reducing oil absorption. The use of protein- and carbohydrate-based edible coatings for fried products results in better moisture retention, ultimately leading to products with lower fat content (Liberty and Dehghannya, 2019).They can be included in food compositions to improve texture, stabilise emulsions, and increase viscosity. When it comes to minimising oil absorption, hydrocolloids can be utilised to enclose food particles in a barrier that stops the absorption of oil during frying. Pectin is one hydrocolloid that is frequently used to lessen oil absorption. Pectin is a cellulose derivative that can be used to make a gel-like substance that can cover food particles and is soluble in cold water. By reducing the amount of oil absorbed while frying, this coating contributes to a lighter and less greasy product. Gelatin is another hydrocolloid that is utilised to lessen oil absorption. Gelatin a collagen-derived protein, is frequently added to food to enhance its functioning, such as its capacity to interact with water and produce gels. Gelatin can assist in lowering the amount of oil absorbed during frying by providing a barrier around food particles when added to food recipes. Hydrocolloids reduces oil absorption by possessing good barrier property against oxygen, carbon dioxide and lipids. Hence it has a special interest in cooking experiments (Singthong, 2009). When food is coated with hydrocolloids it hinders the absorption of oil and improves the nutritional quality during deep fat frying. It also reduces the fat and calorie content. It controls the water loss and prevents the oil entering in to the food product (Varela, 2011). The present study was aimed to investigate the influence of hydrocolloids Pectin and Gelatin to reduce the oil absorption in fried lotus root chips.

MATERIALS AND METHODS

Preparation of lotus root chips

The lotus root was washed cleanly, peeled using a peeler and cut into round slices of 0.2 cm thickness. The slices were blanched in calcium chloride solution (0.5g /100ml distilled water) at 85^0C for 30 seconds. After blanching, the lotus root slices were immersed immediately in different concentration of pectin and gelatin per100ml distilled water at 37^0C for 2 min then, all pieces were dried in the hot air oven at 60^0C for 6 mins. The dried lotus roots were fried in groundnut oil at 180^0 C till the surface becomes golden brown. Uncoated lotus slices were used as a control sample. Lotus root chips were analyzed for the moisture content, fat content, texture, colour and sensory evaluation.

Estimation of moisture by hot air oven method (AOAC 1999)

A previously cleaned and dried petri plate was weighed (W). 5g of sample was weighed in a clean, previously dried and pre-weighed petri plate (W1). The Petri plate was then placed in a hot air oven at 102ºC for 6hours and cooled in a desiccator. After cooling the Petri plate was weighed for moisture content (W2). The difference in weights between the empty Petri plate and the Petri plate after dying in triplicates determined the moisture content of the sample.

Moisture content (g %) **=**W1-W2/W1-W*100

Where,

W – Weight of the empty Petri plate

W1 – Weight of the sample + Petri plate (g)

W2 – Weight of the Petri plate + dried sample

Estimation of lipid by Soxhlet method

Automated Soxhlet fat extractor system is used for fat extraction through gravimetric method. The Soxhlet extraction technique had been utilized to determine the oil content of the samples. Initially, the empty thimble (W1g) was weighed, followed by the transfer of 8 to 10 grams of the sample into the thimble (W2). The Soxhlet extractor was then secured, with a pre-weighed flask (W3) positioned appropriately. The sample was introduced into the extractor, and an excess of petroleum ether was added. With the water condenser affixed to the extractor, the extraction apparatus was operated for a duration of 14 to 16 hours. Following the completion of the extraction, the flask was disconnected, and the solvent was evaporated. To eliminate any remaining solvent traces, the flask was subjected to heating in an oven at temperatures ranging from 60 to 700°C for a period of 30 minutes. After cooling, the weight of the flask (W4) was recorded. It's important to note that the entire experimental procedure was conducted in triplicate.

% of fat = (Weight of fat x 100) / weight of the sample

= (W4 – W3) x 100 / (W2-W1)

Texture analysis

The crispness of the lotus root chips was evaluated in the terms of hardness by texture analyzer with 2mm stainless steel blade probe with a 5N load and a trigger force of 20g. The force in compression mode was measured using a 2 mm blade probe. The lowest value of the hardness indicated the high crispness value and the highest value of the hardness indicated the low crispness value (Muhamad and Shaharuddin, 2019)

Determination of colour

Colour attributes of the samples were determined by using colourimeter. The colour reading consists of three components: brightness (L*), redness (a*), and yellowness (b*). Where L* represents the lightness, a* represents redness and b* represents yellowness. The samples were crushed into fine powder to obtain uniform colour value. A consistent white colour was used to standardise the equipment (Maity et al., 2015).

Sensory analysis

The sensory evaluation of the lotus root chips was conducted by 25 semi-trained panellists. The panellist evaluated the samples based on 9-point hedonic scales on attributes of Colour, appearance, taste, texture and overall acceptability (Hua et al., 2015)

Statistical analysis

One-way analysis of variance (ANOVA) and the Duncan multiple range test were used in the statistical analysis with a significance level of 0.05. Version 16 of SPSS Inc.'s analytic programme was utilised. The mean value and standard error were used to express the data. All the test was done in triplicate and mean value is used for analysis.

RESULTS

Moisture and lipid content in treated lotus root

The Moisture and lipid content results of the samples were shown in Table 1. There is significant increase in the moisture content of the pectin treated lotus root chips. When concentration of the pectin increased, the moisture content of the pectin treated lotus root chips also increased. In gelatin, low concentration decreased the moisture content and increased gelatine concentration also increased the moisture content of the fried lotus root chips. There is significant decrease in the fat content of the pectin and gelatin treated lotus root chips as the concentration of the pectin and gelatin was increased.

Table: 1 Moisture and Lipid content of treated lotus root chips

Sample	Moisture %	Lipid content%
Control	73.80±0.17	27±0.73
P1	78.58±0.62	20±0.07
P2	83.30±0.82	18±0.31
P3	86.51±0.57	15±0.06
G1	64.19±0.51	24±0.02
G2	68.24±0.60	22±0.70
G3	71.95±0.22	20±0.76

Where P1, P2 and P3 is pectin 0.5%, 0.75% and 1% respectively. G1, G2 and G3 is gelatin 0.5 %, 0.75% and 1% respectively.

Table 2: Texture analysis of lotus root chips

Sample	Hardness(g)
Control	587.211±92.03
P1	832.463±74.54
P2	933.342±17.21
P3	952.463±74.54
G1	822.345±92.11
G2	934.226±91.18
G3	945.541±78.45

Texture analysis

The texture (hardness) of the sample is showed in Table 2. The hardness value increased with increase in hydrocolloid concentration. There was a significance difference ($p<0.05$) between control and hydrocolloid treated samples. There was no significant difference found in between the hydrocolloid treated samples. When the hardness of chips increases or reaches its maximum, it will increase the crispiness of the chips.

Colour analysis

The colour of the control sample and the experimental sample is shown in Figure 1. The colour of control chips was lighter than the treated lotus root chips. The L*, a* and b* value increased when the pectin and gelatin concentration increased. There is a significant difference ($p>0.05$) between the Control and experimental samples. No significant difference was observed between the experimental samples. The colour analysis results are shown in Table 3.

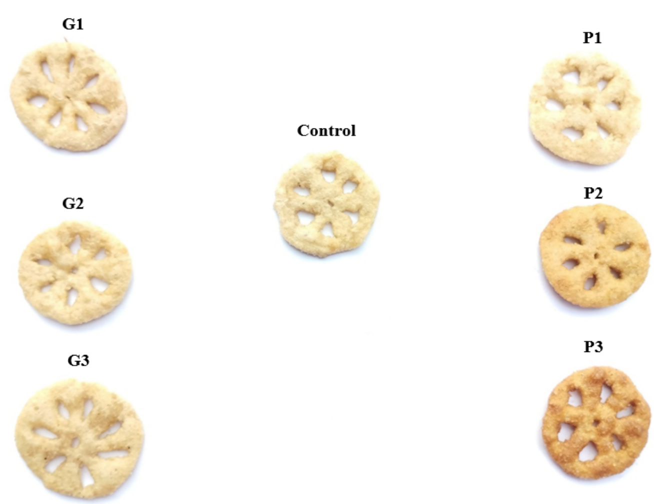

Figure 1: Control and Treated lotus treated chips.

Table 3: Colour analysis

Sample	L*	a*	b*
Control	62.74 ± 1.722	0.90 ± 0.23	20.04 ± 0.84
P1	48.48 ± 5.80	1.29±0.52	15.25 ± 1.44
P2	41.32 ± 3.51	1.34 ± 0.20	15.14 ± 2.26
P3	56.51 ± 1.76	1.53 ± 0.18	14.99 ± 1.08
G1	48.87 ±2.43	1.23±1.02	13.84±0.20
G2	48.62 ±7.21	1.39±0.67	13.12±1.74
G3	46.81 ±0.33	1.43±0.53	12.98±3.43

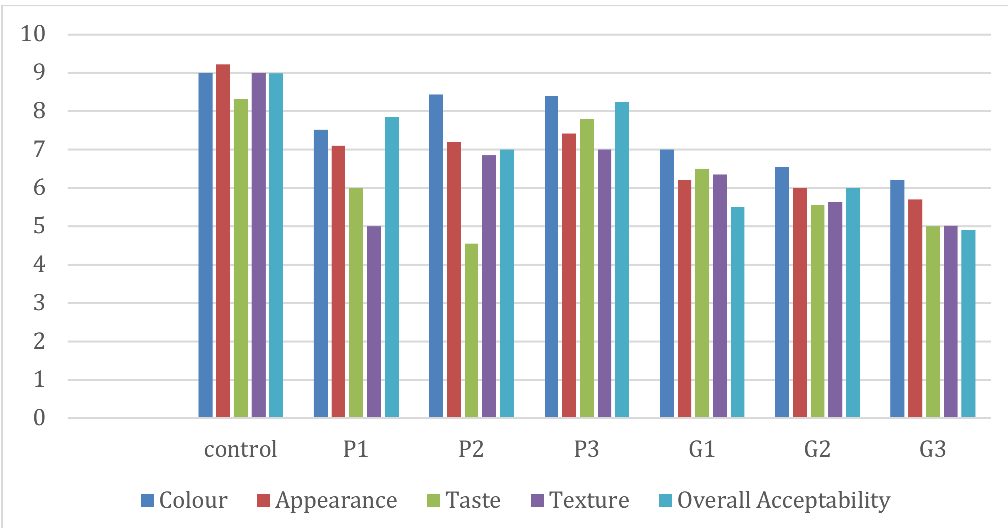

Figure 2: Sensory Characteristics of Lotus Root Chips

Sensory analysis

The fried lotus root chips were coded and sensory evaluation was conducted using 9- Point hedonic scale. The sensory evaluation results showed that lotus root chips treated with 1g of pectin was acceptable in colour, appearance, aroma, texture. There is no significant difference ($p>0.05$) between control P3 sample. The appearance of the treated chips was darker than the control sample. Even though the P3 sample colour was darker than the control it was appealing for the panellist. When the pectin concentration increased the sensory scored increased. But in gelatin treated chips, the sensory score decreased when the concentration increased. The pectin pre-treatment enhanced the mechanical strength of the lotus root tissue, leading to improved structural integrity and higher sensory scores. The sensory results of the control and experimental sample is shown in the figure 2.

DISCUSSION

The study aimed to investigate the effect of pectin and gelatin on the moisture and fat content of fried lotus root chips. The results showed that pectin and gelatin treatment significantly affected the moisture and fat content of the chips. Pectin treatment resulted in an increase in the moisture content of the chips, while gelatin treatment led to a decrease in moisture content at lower concentrations and as increase at higher concentrations. Both pectin and gelatin treatment resulted in a significant reduction in the fat content of the chips, with higher concentrations leading to a greater reduction. Pectin to reduce oil absorption could be due to increase in water holding capacity by entrapping food moisture inside and preventing moisture replacement by oil. Hydrocolloids and calcium chloride has gel forming agent and crosslinking agent form of fine network structure which prevent oil migration during frying process (Singthong, 2009). Sakhale et al. (2011) observed increased in moisture content in hydrocolloid treated samosa with decrease value in oil content. According to Hua et al. (2015) experimental findings, the edible coating made with 1.0% (w/v) sunflower head pectin and 0.05 mol/L CaCl2 can reduce oil uptake by around 30% compared to potato slices that aren't coated. They achieved results that were comparable to the edible coating made from 3.0% (w/v) Methyl cellulose. The L* index value was decreased and the b* considerably changed towards yellow in the instance of potato slices coated with methylcellulose, giving them a dark yellow hue. The sensory evaluation results showed that the chips treated with 1% pectin were acceptable in terms of colour, appearance, aroma and texture. The concentrations of pectin and gelatin treatment led to darker colour and decreased texture with increasing hydrocolloid concentration. Yu et al. (2016) examined the impact of Guar gum coating on the properties and oil uptake of fried potato chips. The decrease in hardness and loss of texture in the uncoated fried chips were attributable to structural alterations in the cell walls (Weerasekera and Navaratne, 2015). The Maillard Reaction, which is influenced by sugars and amino acids on the surface of the chips, temperature, and frying time, changed the colour of the food while frying. During frying, temperature and time should be kept constant to avoid unfavourable taste and smell in hydrocolloid treated chips (Muhamad and Shaharuddin, 2019). Alginic acid and pectin seems to be promising inhibitors of the development of acrylamide, and immersion time is a key factor in determining how well they work to prevent acrylamide synthesis in goods made from fried potatoes (Zeng et al., 2010).

CONCLUSION

Hydrocolloid such as pectin and gelatin have the capacity to reduce the oil absorption during the frying process. The concentration of the hydrocolloid plays an important role in the frying process, because as the concentration of the hydrocolloid is increased, the resulting final product will be less in fat content. Hence hydrocolloids can be effectively used for reducing the oil absorption capacity in the frying process.

REFERENCES

Dhall R. K. 2013. Advances in edible coatings for fresh fruits and vegetables: a review. Critical reviews in food science and nutrition, 53(5), 435–450. https://doi.org/10.1080/10408398.2010.541568.

Dilucia F, Lacivita V, Conte A, Del Nobile MA. Sustainable Use of Fruit and Vegetable By-Products to Enhance Food Packaging Performance. Foods. 2020; 9(7):857. https://doi.org/10.3390/foods9070857

Fakhreddin Salehi 2020. Edible Coating of Fruits and Vegetables Using Natural Gums: A Review, International Journal of Fruit Science, VOL. 20, NO. S2 S570-S589, DOI: 10.1080/15538362.2020.1746730.

Giovanna Ferrentino, Md. Asaduzzaman and Matteo Mario Scampicchio .2018.Current technologies and new insights for the recovery of high valuable compounds from fruits by-products, Critical Reviews in Food Science and Nutrition, Pages 386-404 , 58:3, 386-404, DOI: 10.1080/10408398.2016.1180589.

Khaliq, G., Ramzan, M., and Baloch, A. H. 2019. Effect of Aloe vera gel coating enriched with Fagonia indica plant extract on physicochemical and antioxidant activity of sapodilla fruit during postharvest storage. Food chemistry, 286, 346–353. https://doi.org/10.1016/j.foodchem.2019.01.135

Kumar S, Bhatnagar T. 2014.Studies to enhance the shelf life of fruits using Aloe vera based herbal coating: A Review, Noida Int. Uni., Greater Noida, and U.P 2014.International Journal of Agriculture and Food Science Technology. ISSN 2249-3050 Volume 5, Number 3.

Khayelihle Ncama, Lembe Samukelo Magwaza, Asanda Mditshwa, Samson Zeray Tesfay,Plant-based edible coatings for managing postharvest quality of fresh horticultural produce: A review, Food Packaging and Shelf Life, Volume 16,2018,Pages 157-167,ISSN 2214-2894,https://doi.org/10.1016/j.fpsl.2018.03.011.

L Suriati et al.2018 .IOP Conf. Ser.: Earth Environ. Sci. 207 012051 DOI 10.1088/1755-1315/207/1/012051.

Nair, M. S., Tomar, M., Punia, S., Kukula-Koch, W., and Kumar, M. 2020. Enhancing the functionality of chitosan- and alginate-based active edible coatings/films for the preservation of fruits and vegetables: A review. International journal of biological macromolecules, 164, 304–320. https://doi.org/10.1016/j.ijbiomac.2020.07.083

Neha Babbar, Harinder Singh Oberoi and Simranjeet Kaur Sandhu .2015. Therapeutic and Nutraceutical Potential of Bioactive Compounds Extracted from Fruit Residues, Critical Reviews in Food Science and Nutrition, 55:3, 319-337, DOI: 10.1080/10408398.2011.653734

Otoni, C.G., Avena-Bustillos, R.D., Azeredo, H.M., Lorevice, M.V., Moura, M.R., Mattoso, L.H., and Mchugh, T.H. 2017. Recent Advances on Edible Films Based on Fruits and Vegetables-A Review. Comprehensive reviews in food science and food safety, 16 5, 1151-1169.

Prasad, P. and Kochhar, A. 2014. Active Packaging in Food Industry: A Review. IOSR Journal of Environmental Science, Toxicology and Food Technology, 8, 1-7. https://doi.org/10.9790/2402-08530107

Raghav, P.K., Agarwal, N. and Saini, M.,2016 ¡°Edible coating of fruits and vegetables: A review. International Journal of Scientific Research and Modern Education¡±, 1(1). 188-204.

Rehman, M.A.; Asi, M.R.; Hameed, A.; Bourquin, L.D. Effect of Postharvest Application of Aloe Vera Gel on Shelf Life, Activities of Anti-Oxidative Enzymes, and Quality of 'Gola' Guava Fruit. Foods **2020**, 9, 1361. https://doi.org/10.3390/foods9101361

Rojas-Graü, M.A., M.S. Tapia, F.J. Rodríguez, A.J. Carmona, and O. Martin-Belloso. 2007. Alginate and gellan-based edible coatings as carriers of antibrowning agents applied on fresh-cut Fuji apples. Food Hydrocoll. 21(1):118–127. Doi: 10.1016/j.foodhyd.2006.03.001.

Romanazzi, G., Feliziani, E., Baños, S. B., and Sivakumar, D. 2017. Shelf life extension of fresh fruit and vegetables by chitosan treatment. Critical reviews in food science and nutrition, 57(3): 579–601. DOI: 10.1080/10408398.2014.900474.

Salehi, F. 2017. Rheological and physical properties and quality of the new formulation of apple cake with wild sage seed gum (Salvia macrosiphon). Journal of Food Meas. Charact, 11(4): 2006–2012. doi: 10.1007/s11694-017-9583-5.

Singh, N. 2019. Innovations of edible coating for enhancement of shelf life and quality management of papaya fruit (Carica papaya L.). International Journal of Advanced Research, 7: 1084-1095. 10.21474/IJAR01/9596.

Sumonsiri, N., Charoensantisuk, K., Paonoi, N., and Kittayangkul, P. 2022. Physical properties and sensory acceptability of gum arabic-coated cherry tomato fruit during storage. Food Research. DOI:https://doi.org/10.26656/fr.2017.6(3).395

Tiwari R. 2014. Post-harvest diseases of fruits and vegetables and their management by bio-control agents, Journal of Food Research, 6(3): 395, https://doi.org/10.26656/fr.2017.

Yousuf, Owais and Dubey, Priyanka. 2021. An Overview of Fruit by-products Valorization: A step towards Sustainable Utilization. Indian Journal of Pure and Applied Biosciences, 9(1): 46-55.

Yousuf, Owais and Singh, Anupama. 2018. An innovative approach of development of edible coating for fresh cut apple fruit for value addition of horticultural produce, Journal of Pharmacognosy and Phytochemistry 2018; 7(3): 2353-2355.