Journal of Food and Dairy Sciences

Journal homepage: www.jfds.mans.edu.eg
Available online at: www. jfds.journals.ekb.eg

Effect of Rice Flour Addition on Batter Quality and Oil Absorption of Deep-Fat Fried Potato Strips

Shokhan H. Hamarashid*

Department of Food Science and Quality Control, College of Agricultural Engineering Science, University of Sulaimani, Sulaimanyah, Kurdistan Region, Iraq

ABSTRACT

The effect of adding different proportions of rice flour, including 10%, 20%, 30%, and 50% to the batter formulations, on the properties of the high-fat potato chips were evaluated. Batter layer absorption, moisture content, oil content, and sensory evaluation including appearance, porosity, texture, color, and oily mouthfeel of potato strips were determined. A batter formulation without the addition of rice flour was used as a control. Rice flour-based dough did not have significant impacts ($p < 0.05$) on dough absorption. On the other hand, RFBB3, which was the batter based on rice flour (30%), had the lowest oil absorption compared to other samples, but not significantly different ($p < 0.05$). Meanwhile, the same sample had the highest and significantly different moisture content ($p < 0.05$). In general, the addition of rice flour by the different rates provided a reduced oil absorption compared to the control, but no significant differences ($p < 0.05$). The best result was obtained for the rice flour-based dough (30%) because it had the lowest absorbed oil content and the highest moisture content compared to the other samples. In addition, the addition of that rate of rice flour is the most accepted by the consumer in a significant way.

Keywords: Rice flour-based batter, Wheat flour-based batter, Deep fat frying, Potato strips, Sensory evaluation.

INTDODUCTION

Eating battered foods, especially seafood, poultry, and potatoes, has become very popular in recent years. Frying batters are used to improve the quality of the product. The basic quality factors in fried foods are texture, moisture, oil content, porosity, color, flavor, and nutritional value. Porosity increases during the frying process and is related to oil absorption (Pinthus *et al.*, 1995). Gamble, Rice, and Selman (1987) reported a linear relationship between oil absorption and water removal. There is evidence that dough coating reduces moisture loss during the frying process (Hamarashid 2013 and Mohamed *et al.*, 1998).

The dough is used to improve the quality of the product. Therefore, chemical browning reactions between reducing sugars and protein sources, absorption of frying oil, density of the fried product, temperature and frying time lead to the development of color during the frying process. Furthermore, the dough is defined as a regular layer that is applied before the frying process. It can promote the properties of food, including texture, taste, and appearance. According to Chen *et al.*, (2009) and Salvador *et al.*, (2005) the characterization of food products can be provided by coating systems. Battered foods are more tender and juicy than other foods because the batter covers the food properly.

In the frying process, the most preferable way to reduce oil absorption is the batter formulation (Surojanmetakul, *et al.* 2020). There are many factors that affect the properties of the dough, such as the ingredients in the dough, the temperature and duration of the frying process, and the heating method. It is known that the main and common ingredient in the dough formulation is wheat flour. It helps to absorb more oil during the frying process (Adedeji and Ngadi 2011). That point has direct contact with many diseases such as obesity and diabetes, etc. So, in the last year, rice flour was used as an alternative to wheat flour in a batter formulation. One of those reasons is the least sensitizing of the common cereals and the least allergic (Adedeji and Ngadi 2011).

Additionally, rice flour-based batter formulations would add value to rice and provide an alternative for people with a gluten allergy (Dogan *et al.*, 2005). Rice flour is absolutely different from wheat flour because rice flour is gluten free. Wheat flour rich in protein between 10 and 13.3%, especially gluten, which causes the absorption of more oil during frying (Adedeji and Ngadi 2011). Whereas, rice flour contains 7.2% protein and gluten-free that helps absorb less oil (Adedeji and Ngadi 2011, Shih and Daigle 2001). In general, in most countries, the consumption of rice and processed foods made with rice has increased, especially in countries where rice is an essential food (Esa *et al.*, 2016). This is because the rice industry remains sustainable for a long time (USDA., 2020).

The main objective of this research is to find the impact of adding rice flour in different proportions (0%, 10%, 20%, 30% and 50%) on the quality, oil absorption and moisture content of the potato. fried in fat. strips. Consequently, another objective of this study is to determine the best flour addition rate in terms of quality and greater acceptance by the consumer through sensory evaluation.

MATERIALS AND METHODS

Materials

Wheat flour, rice flour, yeast (baking powder), salt, sunflower oil, hexane and potato were used throughout the study. In addition, all the materials were purchased from the local market, Sulaimanyah. The wheat flour contained 10.3% protein, 70.6% carbohydrates. The salt (sodium chloride) contained material to prevent grounding (potassium ferro cyanide E536)

* **Corresponding author.**
E-mail address: shokhan.hamarashid@univsul.edu.iq
DOI: 10.21608/jfds.2020.118361

and potassium iodate. The leavening agent consisted of sodium pyrophosphate, sodium hydrogen carbonate. Hexane was used as the main solvent in the Soxhlet extraction for oil extraction.

Preparation of batter

The dough consisted of wheat flour, rice flour, leavening agent, salt and tap water in 1: 1.5 weight of ingredients / weight of water. The doughs were prepared by mixing the dry ingredients with water. Then manually mix the dry ingredients with water to make the batter. It must not contain any aggregation. The shake formulation is shown in table 1.

Table 1. Formulation for batter system (100gm)

Ingredients	WFBB	RFBB1	RFBB2	RFBB3	RFBB4
Wheat flour	96.5	86.85	77.2	67.55	48.25
Rice flour	0	9.65	19.3	28.95	48.25
Salt	2.5	2.5	2.5	2.5	2.5
Leaving agent	1	1	1	1	1

WFBB= Wheat Flour Based Batter (Control) %0, RFBB1= Rice Flour Based Batter %10, RFBB2= Rice Flour Based Batter%20, RFBB3= Rice Flour Based Batter%30, RFBB4= Rice Flour Based Batter%50

Potato Preparation

Potato was used as a modal food in this study (Garcıa *et al.*, 2002, Hamarashid 2013, Rimac-Brnci, *et al.*, 2004, and Sun-Waterhouse *et al.*, 2012). They were washed, peeled and cut manually. Based on Garcıa, *et al.*, 2002 the potatoes were cut into regular strips that around 0.7×0.7 length × 5 width cm. then weighed individually before use in the experiments.

Batter Pickup

Batter pickup 'is the amount of batter that adheres to the modal food (Varela and Fiszman, 2011). In addition, improve the properties of the potato chip and reduce the correction and bad taste of it (Collin *et al.*, 2000). According to Chen *et al.*, 2008 to measure dough pick up here, the uncoated potato strip was weighed, then dipped into the dough for 10 seconds and directly weighed again. The mass collection was determined by the following equation:

$$Batter\ Pickup(\%) = \frac{\text{Weight of Coated Potato} - \text{Weight of Uncoated Potato}}{\text{Weight of Uncoated Potato}} \times 100$$

Deep Fat Frying Process

The potato strips were fried with sunflower oil. The potato strips were fried in a batch system of four fried pieces in the same pan at the same time. After frying each batch, the oil level in the pan was checked for any decrease in volume. In a frying pan, the amount of oil was much greater than potato strips by 1: 6 (potato strip: oil) (Rimac-Brnci *et al.*, 2004).

Moisture Content Analysis

Moisture or water content in all samples was determined by oven drying process at 105°C until samples reached constant weight (AOAC 2004). The moisture content was determined by the following equation:

$$Moisture\ (\%) = \frac{\text{Initial Weight of Sample} - \text{Final Weight of Sample}}{\text{Initial Weight of Sample}} \times 100$$

Fat Content Analysis

Soxhlet extraction was used to determine the oil content in the sample after processing (AOAC. 1999). After reaching 68°C, which is the boiling point temperature of hexane. The oil extraction technique needs a long time which was 3-4 hours. After evaporation of the solvent, the extracted oil was weighed and then calculated using the following equation:

$$Oil\ Content\ (\%) = \frac{\text{Weight of Extracted Oil}}{\text{Weight of Sample}} \times 100$$

Sensory evaluation

When fried potato strips coated with the different dough formulations were prepared, they were left at room temperature for approximately 5 to 10 minutes and then evaluated by the panelist (score 0 to 10). Sensory tests were carried out with 28 untrained panelists. 8 of those who are teachers and 20 of those who were students. All members of the College of Agricultural Engendering Science. Sulaimani University.

Statistical analysis

Data statistical analyses for current study were subjected to a one-way analysis of variance (ANOVA) using XL Stat for Windows. Variations between means were calculated using LSD tests. The significant concentration was chosen in ($P < 0.05$) and the final results were given as a mean.

RESULTS AND DISCUSSION

Effect of rice flour on batter pickup

The effect of the addition the different rate of rice flour (0%, 10%, 20%, 30% and 50%) on the batter pick-up of potato strips is presented in Figure 1.

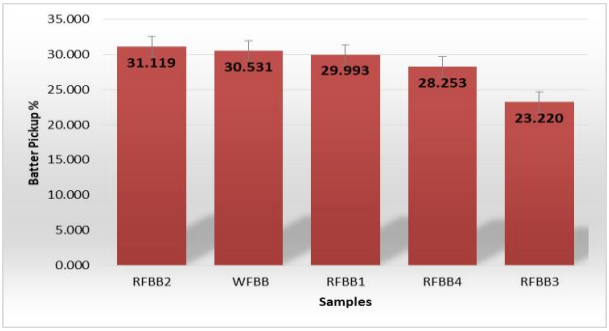

Figure 1. Effects of addition different rates of rice flour on batter pick-up for fried potato strips.(WFBB) wheat flour based batter/ Control; (RFBB1) contain 10% rice flour; (RFBB2) contain 20% rice flour; (RFBB3) contain 30% rice flour; (RFBB4) contain 50% rice flour.

*** Means with LSD-value 7.599 are not significantly different (p>0.05).**

The batter based on rice flour at 20% had the highest collection value of the batter and there are no significant differences ($p < 0.05$) between the treatments at 0, 10, 20%. Akdeniz *et al.*, 2006 reported that increasing viscosity causes increased uptake of dough. Therefore, mass coating and viscosity have a direct correlation. In the present work, it can be said that the addition of a different rate of rice flour did not have a significant effect on increasing the uptake of the coating mass as shown in Figure 1. In general, the addition of flour of rice to the dough formulation leads to a non-significant decrease that a dough collects as seen in the dough based on 10%, 30% and 50% rice flour. Also, the 30% rice flour-based dough had the least amount of dough compared to other samples, which may result in the rice flour having less ability to bind water. Therefore, more free water was available to facilitate the movement of the particles in the rice flour by adding batters giving low viscosity values (Dogan *et al.*, 2005). On the other hand, the smallest value for batter obtained in 30% rice flour batter could. As a result, the addition of rice flour leads to a decrease in the adherence of the batter to the potato strips. Depending on this result, the addition of certain levels of rice flour may not increase the absorption of the coating, but may still play a role in delaying oxidation and protecting a food product from spoilage (Yerlikaya *et al.*, 2009).

Oil Uptake

The impact of adding different proportions of rice flour in the batter formulations on the oil absorption of the potato strips during frying is shown in Figure 2. The results show that the addition of flour to the batter formulation can decrease oil absorption during deep frying process, but none significantly.

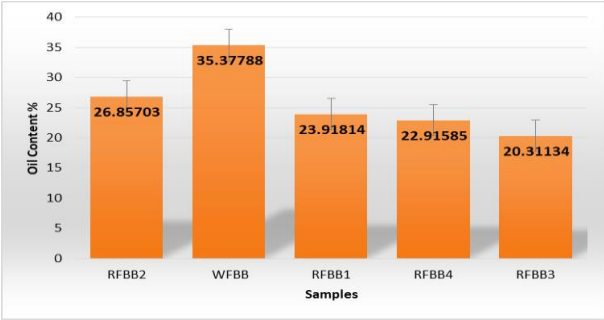

Figure 2. Effects of rice flour on oil content of deep fat fried battered potato strips.(WFBB) wheat flour based batter/ Control; (RFBB1) contain 10% rice flour; (RFBB2) contain 20% rice flour; (RFBB3) contain 30% rice flour; (RFBB4) contain 50% rice flour.

*** Means with LSD-value 49.208 are not significantly different (p>0.05).**

Moisture Content

Furthermore, the increase in oil content is related to the increase in protein content (Shuey 1968) but depends on the type of flour. Wheat flour contains slightly more protein than rice flour. So, the protein rate was 10 to 13% in wheat flour and 6.68% in rice flour (Wanyo *et al.*, 2009). In addition, Shih and Daigle (1999) found that the proteins and starch in rice flour are chemically different from those in wheat flour. They reported that the rice flour-based batter absorbed substantially less oil than the wheat flour-based batter. Substitution of modified starch in the batter formulation could decrease oil absorption in the fried batter potato strips. In the general quality of fried food, rice flour is better than wheat flour. Because rice flour has the ability to reduce oil absorption more than wheat flour (Nakamura and Ohtsubo 2010).

The effect of adding rice flour to the coating formulation on the moisture content was found and is shown in Figure 3. According to the results, the addition of rice flour to the coating formulation significantly influenced the amount of content of humidity. As seen, the 30% rice flour-based batter was the highest value, which was 65.072%, followed by the 50% rice flour based batter values were 58.375%. As mentioned above, that rice flour-based dough (30%) had the lowest oil content. Therefore, moisture content and oil absorption have an inverse relationship. It means that losing a large amount of water during deep frying leads to increased oil absorption from the food product (Akdeniz *et al.*, 2006). Another reason for raising the moisture content is that it allows the amylose to act as a protective barrier, reducing moisture loss and decreasing the space for oil absorption. Then, the increase in the amylose content resulted in an increase in the moisture content, and this is related to the amylose function as a gel former (Dogan *et al.*, 2005).

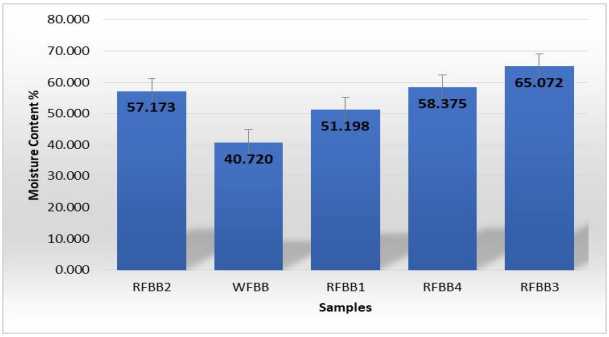

Figure 3. Effects rice flour on moisture content of deep fat fried battered potato strips. (WFBB) wheat flour-based batter/ Control; (RFBB1) contain 10% rice flour; (RFBB2) contain 20% rice flour; (RFBB3) contain 30% rice flour; (RFBB4) contain 50% rice flour.

*** Means with LSD-value 1.486 are significantly different (p>0.05).**

Sensory evaluation

The range of differences between samples for each sensory quality was measured on a standard nine-point hedonic scale. The raters rated the striped potato chip samples on appearance, porosity, texture, color, oily mouthfeel, and general acceptability successively on a scale ranging from 1 = extremely dislike to 9 = extremely (Table 2). Generally, the results indicated that the addition of rice flour to the batter formulation significantly improves the development of fried product properties. For water holding capacity, rice flour is better than wheat flour. Based on it, it could be healthier (Adedeji and Ngadi 2011). Depending on overall acceptability (Table 2), the 30% rice flour-based dough had the highest score for all properties. So, it means that rice flour-based dough coated potato strip is more accepting than other coated potato strips.

Sensory score for texture and color increased with increasing rate of rice flour addition, expected in rice flour-based dough by 50%. The control sample (0% rice flour) scored the lowest for texture and color. The addition of rice flour to the batter formulation improves the general acceptance for the potato strips, which was significantly different ($p < 0.05$). For the oily mouthfeel, the data shows that the 50% rice flour-based dough was less accepted compared to other samples.

Table 2. Sensory evaluation for fried potato strips coated batter with different rate of rice flour.

Properties	WFBB	RFBB1	RFBB2	RFBB3	RFBB4
Appearance	7.901b	7.728b	8.623a	8.623a	7.790b
Porosity	7.194b	7.130b	7.454b	8.167a	7.352b
Texture	6.759c	7.602b	7.602b	8.602a	7.602b
Colour	7.370b	7.611b	8.611a	8.722a	7.426b
Oily Mouth feel	7.250b	7.509b	7.352b	8.157a	6.769c
Overall Acceptance	7.295d	7.516c	7.928b	8.454a	7.441c

(WFBB) wheat flour-based batter/ Control; (RFBB1) contain 10% rice flour; (RFBB2) contain 20% rice flour; (RFBB3) contain 30% rice flour; (RFBB4) contain 50% rice flour.

*** Values with different letters (a,b,c,d) in a row indicate statistical difference (p<0.05)**

CONCLUSION

The addition of different proportions of rice flour to the dough formulation was influencing the quality properties, coating pick-up and oil absorption during deep frying and moisture content. Furthermore, the addition of 30% rice flour to the batter was selected as the best compared to a different rate, which was 0%, 10%, 20% and 50%. Therefore, you can produce a healthier potato by being amylose and starch and gluten-free which then absorbs less oil than others. When all quality parameters were considered, the rice flour mixture significantly increased the overall acceptability, improved the appearance, the color, and decreased the oil content of the potato strips. Due to the substitution of a considerable amount of wheat flour for rice flour, it can be recommended for use in batters for potato strips.

REFERENCES

Adedeji, A., A., and Ngadi, M., O. 2011. Microstructural Properties of Deep- Fat Fried Chichen Nuggets coated with different Batter Formulation. *International Journal of Food Properties*, 14:68–83. Canada.

Akdeniz, N., Sahin, S., Sumnu, G., 2006. Functionality of batters containing different gums for deep-fat frying of carrot slices. *J Food Engineering* 75, 522-526.

AOAC 2005. Official methods of analysis (18th ed.). Method 28.074. Washington, DC: Association of Official Analytic Chemists.

AOAC 1999. Offical method of analysis (16th ed.). 5th Rev. International, Official methods of analysis, Soxhlet extraction.

Chen, H. H., Kang, H. Y., Chen, S. D., 2008. The effects of ingredients and water content on the rheological properties of batters and physical properties of crusts in fried foods. *J Food Engineering* 88, 45–54.

Chen, S., Chen, H., Chao, Y., Shinn Lin, R., 2009. Effect of batter formula on qualities of deep-fat and microwave fried fish nuggets. *J Food Engineering* 95, 359–364.

Childs, N., 2020. Rice Sector at a Glance. United States Department of Agriculture Economic Research Service USDA. USD.

Collin, S., F., Summers, A., Woodbury, B., L., Cram, M J., E., 2000. Clear coat batter for French fried potato strips. *World Intellectual Property Organization*. WO 00/28828. USA.

Dogan, S. F., Sahin, S., Sumnu, G., 2005. Effects of soy and rice flour addition on batter rheology and quality of deep-fat fried chicken nuggets. *J Food Engineering* 71, 127–132.

Esa, N., M., Ling, T., B., Peng, L., S., 2016. By-products of Rice Processing: An Overview of Health Benefits and Applications. *J Rice Resarch*, Volume 1 Malaysia.

Gamble, M., H., Rice, P., Selman, J., D. 1987. Relationship between oil uptake and moisture loss during frying of potato slices. *International J Food Science & Technology* Volume 22, Issue 3, 233–241.

Hamarashid, Sh., H., 2013. Effects of the addition of phenolic compounds on the rheological properties, coating pickup, and oil content of wheat our based batters. University of Reading. *J Zankoy Suliamani*, 10680.

Moreira, R. G., Barrufet, M. A., 1997. A new approach to describe oil absorption in fried foods: a simulation study. *J Food Engineering* 35, 1-22.

Nakmura, S., and Ohtsubo, K., 2010. Influence of physicochemical properties of rice flour on oil uptake of tempura frying batter. *Bioscience, Biotechnology, and Biochemistry*, 74(12), 2484-2489.

Pinthus, E., J., Weinberg, P., Saguy, I.S. 1995. Oil Uptake in Deep Fat Frying as Affected by Porosity. *The Institutes of Food Technology*. Volume 60, Issue 4, pages 767–769.

Rima-Brn-Ci-C, S., Lelas, V., Rade, D., Simundi-C, B., 2004. Decreasing of oil absorption in potato strips during deep fat frying. *J Food Engineering* 64, 237–241.

Salvador, A., Sanz, T., Fiszman, S. M., 2005. Effect of the addition of different ingredients on the characteristics of a batter coating for fried seafood prepared without a pre-frying step. *Food Hydrocolloids* 19, 703–708.

Sahin, S., Sumnu, G., Altunakar, B., 2005. Effects of batters containing different gum types on the quality of deep-fat fried chicken nuggets. *J Science of Food and Agriculture* 85, 2375–2379.

Shih, F., Diagle, K., 1999. Oil uptake properties of fried batter from rice flour. *J Agriculture Food Chemistry* 47 (4) 1611.

Shih, F., E., And Diagle, K., W., 2001. Rice Flour Based Low Oil Uptake Frying Batters. United States Patent.

Shuey, W., C., Rask, O., S., Ramstad, P., E., 1968. Measuring the Oil- Binding Charactarciecs of Flour. *Crops research division*. Volume 40 USA.

Sun-Waterhouse, D., Xue, D., Wadhwa, S., 2012. Effects of Added Phenolics on the Lipid Deterioration and Antioxidant Content of Deep-Fried Potato Fritters. *Food Bioprocess Technol* 10, 1-10.

Surojanmetakul, V., Karnasuta, S., Satmalee, P., 2020. Effect of oil type and batter ingredients on the properties of deep-frying flakes. *Food Science and Technology*. Brasil.

Varela, P., Fiszman, S. M., 2011. Hydrocolloids in fried foods. A review. *Food Hydrocolloids* 25, 1801-1812.

Vongsawasdi, P., Montia, N., Srisuwatchee, W., Pasukcharoenying, S., Wongkitcharoen, N. 2008. Using modified starch to decrease the oil absorption in fried battered chicken. *As. J. Food Ag-Ind.* 1(03), 174-183. Thailand.

Wanyo, P., Chomnawang, C., Siriamornpun, S., 2009. Substitution of Wheat Flour with Rice Flour and Rice Bran in Flake Products: Effects on Chemical, Physical and Antioxidant Properties. *Sciences Journal* 7 (1): 49-56.

Yerlikaya, P., Gokoglu, N., Topuz, O. K., 2009. Use of natural plant extracts in batter coating of shrimp and their effects on the quality of shrimp during frozen storage. *J Food Processing and Preservation* 34, 127–138.

آثار الإضافة طحين الأرز على جودة الخليط وامتصاص الزيت للبطاطس المقلية

شوخان هيدايت حمة رشيد*

قسم علوم الاغذية والسيطرة النوعية، كلية علوم الهندسة الزراعية، جامعة السليمانية، السليمانية، إقليم كوردستان، العراق

لغرض تقييم اثر اضافة طحين الأرز بنسب مختلفة ١٠٪، ٢٠٪، ٣٠٪ و ٥٠٪ في خصائص التركيب الخليط مع البطاطس المقلية. تم دراسة تماسك الخليط (pick-up of batters)،نسبة الرطوبة، نسبة الامتصاص الزيت و التقييم الحسي والتي تضمنت المظهر الخارجي، المسامية، القوام، اللون و الشعور التزييت بالفم للبطاطس المقلية بالخلطات. شملت معالمة المقارنة عدم أضافة طحين الأرز ، بينما باقي المعاملات شملت اضافة طحين الارز بنسب مختلفة. كانت إضافة طحين الأرز الى الخليط مع البطاطس المقلية تأثير غير معنوى ($p<0.05$) في نسبة تماسك الخليط (pick-up of batters). اضافة ٣٠٪ طحين الأرز الى الخليط (المعاملة الرابعة) سجلت أدنى نسبة امتصاص زيت عند المقارنة بالمعاملات الاخرى لكن لم يفرق معنويا ($p<0.05$)، أعلى نسبة الرطوبة وبفرق معنوي ($p<0.05$) عن باقي المعاملات سجلت في المعاملة الرابعة، بصورة عامة إضافة طحين الأرز بنسب مختلفة خفضت نسبة امتصاص الزيت لكن بصورة غير معنوية. أفضل النتائج هي اضافة ٣٠٪ طحين الأرز الى الخليط لأنه كان لديه أدنى نسبة امتصاص الزيت و أعلى نسبة رطوبة. وأيضا تلك المعاملة هو الأكثر تقبلا وبفرق معنوي .