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Effect of edible coatings on fat absorption of french-fries

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Abstract
In this study effect of four different starch based edible coatings (corn, wheat, rice and cassava) on fat absorption of french-fries during frying process was investigated. Among these four edible coatings corn edible coating was found most acceptable from all sensory attributes point of view and wheat coating was observed to be least accepted by the panel members where no significant difference was noted between the control and experimental samples of french-fries. The edible coatings not altered the sensory characteristics of french-fries and were found to be equally accepted as control samples of french-fries. The coatings pick up and batter uptake per cent was also found higher for corn coated french-fries. The result obtained from fat reduction per cent indicated that all four type of edible coatings has successfully reduced the fat absorption in french-fries samples and among the experimental samples cassava coating was found to be most effective in reducing fat absorption during deep frying of french-fries samples.

Keywords: Edible coatings, starch based coatings, french-fries, fat absorption

Introduction
French fries are one of popular fried food majorly among young generation. The flavor of the fat and salt leads the consumer to consume it often. The potatoes cut into long strips and fried in deep fat known as french fries. Now many restaurants sells the french fires frequently with combination of another food. A large order of French fries may contain approximately 540 calories with 26 g of fat (Lloyd *et al*. 2005) [7]. French fries are prepared by deep frying method. Deep frying is most popular and oldest method of cooking used in India. This method increases the taste, flavour and appearance of food product (Stier, 2004) [8].

In the fried product the high heat transfer and fat is majorly responsible for the enhanced sensory characteristics. As food product is completely deepened in hot cooking oil and then heat and mass transfer starts occurring during deep fat frying. Deep frying method is categorized in dry cooking method because no water is used in this process (Irudayaraj, 2001) [6]. In the deep frying method food product cooks exceptionally fast and takes very less time because of the high temperature and the high heat transmission of oil. In deep frying process food product absorbs large amount of oil. The sensory and health aspects need to be addressed in deep fried food products to meet the demand of consumer. As high absorbance of fat in deep fried food product is one of major cause of high cholesterol level and upshot of the increased prevalence of obesity as well as coronary heart diseases (Garayo and Moreira, 2002) [4]. In current years, consumer's inclination for low fat and fat-free products has driven the force the food industry to explore technology to reduce the fat absorption during the frying process which can still retain the desirable sensory properties. For this purpose hydrocolloid coatings may play an integral role in reducing fat absorption during deep frying.

Hydrocolloids form a fine layer of coating on food product, which is capable to prevent the excessive oil absorption during the frying process of food product. Hydrocolloids are water soluble polymers, potential to gelate aqueous system retaining water in food products. Hydrocolloids are basically hydrophilic in nature hence they bind moisture and also extend shelf life to the fried food product and reduced fat uptake (Dixit *et al*. 2016) [3]. Hydrocolloids are classified in two categories one is protein and another is polysaccharide. Coatings prepared from polysaccharides owned good barrier properties to carbon dioxide, oxygen, lipids and protect against lipid oxidation and low in cost. Therefore present research was aimed to investigate the effect of different polysaccharide based coatings on fat absorption of french-fries.

Methodology

Preparation of coating solutions

Four different aqueous solutions were prepared by dissolving 4 per cent (w/v) of corn, wheat, rice and cassava powder separately in 100 ml of distill water. Two per cent acetic acid (w/v) and plasticizer glycerol (4% w/w) were also added in four different coatings solutions. After that the coatings solutions were heated at 70˚ C for 35 min on hot plate. Before five minutes of removing beakers from hot plate (1% v/w) clove essential oil was incorporated as antibacterial agent in all four different solutions. Solutions were stirred by using vortex mixer for 25 minutes and strained through strainer. The starch based coatings were selected due to gel formation ability of starch in higher temperature which can form a coating layer on food product.

Preparation of French Fries

Ingredients	Amount
Potato	1 kg
Oil	150 ml
Salt	1 tsp

Procedure

- Firstly potatoes were washed, cleaned and peeled off then they were cut sharply lengthwise.
- Sliced potatoes were kept in iced water for 15 minutes in a bowl.
- Water was drained off and potatoes sliced were weighed.

Method of coating

- Now the potatoes sliced were dipped in pre weighed four type different edible film solutions for 20 seconds.
- Fried in pre weighed oil and salt was sprinkled over and mixed gently.
- The fried French fries, left edible solution after coating and left oil were weighed again.

Control Sample

Some pre weighed sliced potatoes were not coated with edible film and fried in different pan and in pre weighed oil, were marked as control samples to determine the oil absorbance difference.

Sensory evaluation

The sensory evaluation of control and experimental samples was conducted to assess the acceptability of coated french fires and to investigate the difference between non coated and coated samples of french fries. The sensory attributes such as color, transparency, appearance, surface smoothness, flavor, texture, taste and overall acceptability were assessed by a panel of 10 trained judges using 9-point Hedonic rating scale.

Moisture content

The moisture loss is directly associated with shelf life of food product hence moisture content of samples was assessed by following AOAC, 2005 [2] method.

Coating pick-up

Coating pick-up of coated samples was calculated from given formula (Garmakhany *et al*. 2011) [5].

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

Where, C is the weight of raw coated sample (g)
and I is the initial weight of raw non-coated sample (g).

Batter uptake

Batter uptake per cent of the product was calculated (Yadav, 2002) [9] by the following formula:

$$\text{Batter uptake (\%)} = \frac{(Bb-Ba)/n}{W} \times 100 \ldots (3.17)$$

Bb = weight of batter mix before enrobing.
Ba = weight of batter mix after enrobing
n = number of sample enrobed
W = weight of each raw sample

Cooking loss

Percentage of cooking loss of frech fries was obtained by considering the weight of the fried product and the raw product after coating (Garmakhany *et al*. 2011) [5]. Cooking loss of the final product was calculated by the following formula:

$$\text{Cooking loss (\%)} = \frac{\text{Final weight of product (g)}}{\text{Initial raw weight of product (g)}} \times 100$$

Fat Reduction (FR)

Fat reduction per cent due to coating was calculated as the weight difference between the oil used of coated and non-coated samples (Dixit *et al*. 2016) [3].

$$\text{Fat reduction (\%)} = \frac{\text{(oil, non-coated sample)-(oil, coated sample)}}{\text{Oil, non-coated sample}} \times 100$$

Statistical analysis

All of the data was statistically analyzed as per the objectives. All these experiments were replicated three times and the average values were reported. For this purpose Mean±SD and Analysis of Variance (ANOVA) were applied. ANOVA is important for determining adequacy and the significance of quadratic model.

Result and discussion

Effect on sensory evaluation

The Figure 1 depicts that scores of color in control french-fries color scores were observed 7.80±0.17 where in coated french-fries scores were ranged from 7.67±0.59 to 8.00±0.22. In the experimental samples highest color scores were noted for corn coated french-fries and lowest were observed for wheat coated samples. This indicates that there was no major color difference between the coated and uncoated samples.

The transparency attribute was not applicable for control as transparency of coating with the product was assessed. In the experimental samples of french-fries it varied from 7.63±0.37 to 8.03±0.24. Similar results were observed for flavour attribute also.

The scores of appearance for all control and experimental samples remained in the category of liked very much to liked moderately at nine point hedonic scale. The control french fries were scored as 7.80±0.42 value for appearance. While coated french-fries exhibited scores from 7.80±0.42 to 8.03±0.33. The sensory scores of texture attribute for control french-fries scored 7.60±0.44. The texture scores in

experimental french-fries it varied from 7.70±0.51 to 7.83±0.28. Where the highest texture scores were found for corn coated samples and lowest values were noted for wheat coated french-fries.

From the taste perspective control french-fries showed 7.70±0.37 scores. While in experimental samples of french-fries samples taste scores varied from 7.73±0.26 to 7.93±0.30. In the experimental samples the maximum scores were noted for corn french-fries and minimum were observed for wheat coated samples. The sensory scores of taste attribute lied in the category of liked very much to liked moderately on nine point hedonic scale. The overall acceptability scores of control french-fries was noted 7.77±0.32. In the experimental samples of french-fries it ranged from 7.77±0.28 to 8.03±0.33, highest for corn coated samples and lowest for wheat coated samples.

Angor, (2016) [1] reported in his study that overall acceptability scores of the coated samples of potato chips were found between the ranges of like very much to like, where the uncoated chips sample had the lowest value score for overall acceptability compared to all coated treatments.

The result of sensory evaluation reveals that control and coated samples were almost equally acceptable from all sensory attribute point of view as, no significant difference was noted in control and experimental samples. In the optimized edible coatings corn coating was found to be most acceptable as compare to the other coatings.

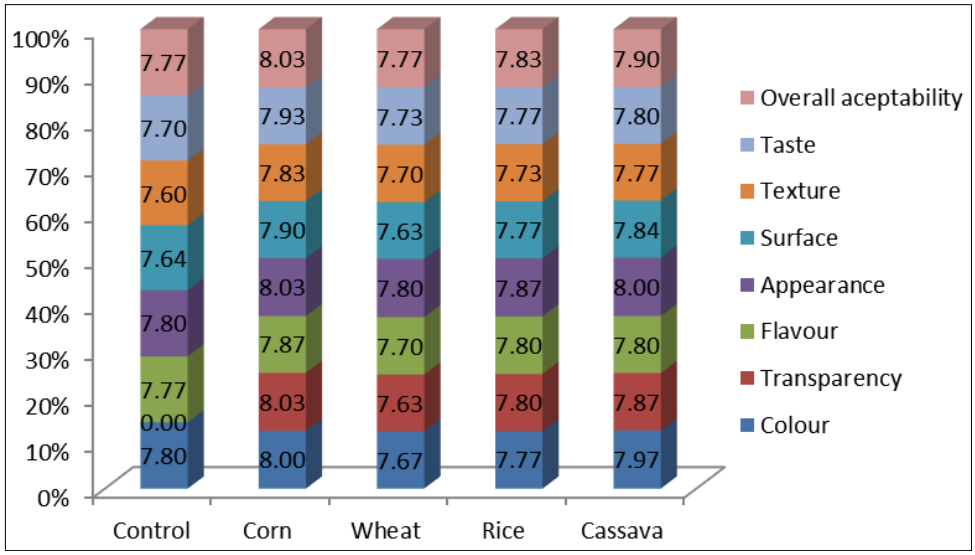

Fig 1: Sensory evaluation of optimized edible coatings effect on fat absorption of french fries

Coating pick up

No significant difference was observed in coating pick up per cent of all coated french-fries. Where, the coating pick up per cent was varied from 5.03±1.34 to 8.09±2.34 (Table1). The highest per cent of coating pick up was observed for cassava coated french-fries and lowest was noted for wheat coated french-fries. Parallel findings were reported by Garmakhany *et al.* (2011) [5].

Batter uptake

Table 1 also illustrates batter uptake per cent of coated french-fries. The coated frech-fries demonstrated 6.85±2.49 to 12.06±3.74 per cent of batter uptake. The corn coated french-fries showed the highest per cent of batter uptake whereas the wheat coated french-fries illustrated lowest batter uptake per cent. The analysis of variance exhibited no significant difference for batter uptake per cent between the edible coated french-fries.

In present study the higher coating pick up and batter uptake per cent of corn coated samples are might be due to the gel formation capacity of the corn starch, as the consistency of corn coating solution was observed more thick in comparison to other solution and vice-versa the wheat coating solution was found to have least consistency, as experienced during research work.

Table 1: Coating pick up percent and batter uptake

Attributes	Type of edible coatings	French fries
Coating Pick-up (%)	Corn	5.84±1.17
	Wheat	5.03±1.34
	Rice	6.23±1.41
	Cassava	8.09±2.34
	SE	0.94
	CD 5%	NS
Batter uptake (%)	Corn	12.06±3.74
	Wheat	6.85±2.49
	Rice	11.86±0.84
	Cassava	6.93±2.23
	SE	1.46
	CD 5%	NS

SE- Standard Error, *- Significant at 5 per cent level, NS-No Significant difference

Cooking loss

Cooking loss was assessed by measuring the weight of the fried product and the weight of coated raw product. The data obtained for cooking loss of control and coated french-fries is presented in table 2. The control french-fries exhibited 87.04±1.64 per cent cooking loss. Whereas in experimental samples cooking loss was found to be ranged from 87.55±3.36 to 90.61±1.99. There was no significant difference was observed in cooking loss per cent of french-fries samples.

The close look of the data depicts slightly higher values of cooking loss in experimental samples as compare to the control but statistically not differed significantly which means optimized edible coatings have not effected the cooking loss per cent much.

Table 2: Cooking loss percent

Attribute	Type of edible coatings	French fries
Cooking loss (%)	Control	87.04±1.64
	Corn	88.86±4.51
	Wheat	90.61±1.99
	Rice	89.71±4.43
	Cassava	87.55±3.36
	SE	1.96
	CD 5%	NS

SE- Standard Error, *- Significant at 5 per cent level, NS-No Significant difference

Fat Reduction (FR)

The fat reduction per cent was calculated by measuring the weight difference between the oil used of coated and non-coated samples. Fat reduction per cent of coated french fries ranged from 33.25±0.41 to 42.65±1.16 (Figure2). The highest fat reduction per cent was found for cassava coated french-fries (42.65%) and lowest per cent of fat reduction was noted for wheat coated french-fries (33.25%). Analysis of variance also exhibited significant difference between the optimized edible coating coated samples of french-fries for fat reduction per cent.

The results indicate that optimized edible coatings have successfully reduced the oil absorption during the frying process in french-fries samples. The cassava edible coating was found most effective in reducing fat absorption during frying as compare to other coatings.

The in line results were found by Dixit *et al*. (2016) [3] as reported maximum oil uptake reduction of tapioca sago chips was found up to 61.46 to 13.35 per cent in coated samples. Further the researcher concluded that the fat reduction could have been due to the formation of film of hydrocolloids on the surface of food product which might have decreased the tendency of the product for oil absorption.

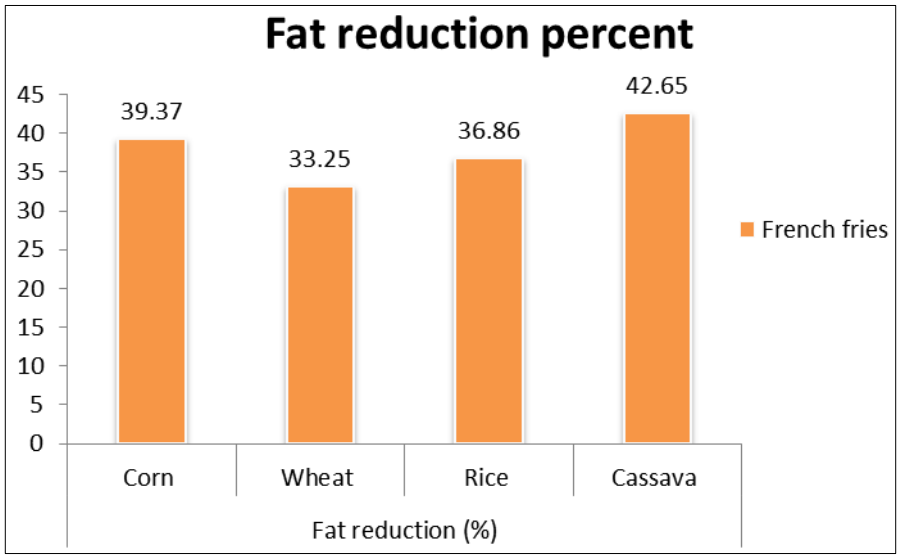

Fig 2: Effect of edible coatings on fat reduction percent of french-fries

Conclusion

In the present study effect of edible coatings on fat absorption of french-fries during frying process was investigated. The result from sensory scores revealed no significant difference between non coated and coated french-fries. Further analysis of variance showed that corn coated samples of french-fries were appreciated most among all the experimental samples. The edible coatings have not altered the sensory characteristics of the frech fries and were equally accepted as control. The coating pick up and batter uptake percent exhibited highest percent for corn coating as corn coating solution was slightly thick as compare to other coating solutions. The result of cooking loss per cent presented no significant difference between control and experimental samples of french-fries. It is evident from the result of fat reduction per cent that edible coatings has been successfully reduced the fat absorption during frying process of french-fries. Among the edible coatings, cassava coating was found effective in reducing fat absorption of french-fries samples.

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