American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-04, Issue-02, pp-27-32
www.ajer.org
Research Paper Open Access

Optimization of Hydrocolloids Concentration on Fat Reduction in French Fries

[1,]Aachal Purwar & [2,]P. A. Pawar
[1,2,]Department of Chemical Technology,
Sant Gadge Baba Amravati University, Amravati-444602, Maharashtra, India

ABSTRACT : *The French fries were prepared from potatoes after pretreating with $CaCl_2$, blanching and then coated with different hydrocolloid solutions. It was observed that French fries pretreated with 0.5% aqueous solution of $CaCl_2$ and coated with 1% aqueous solution of HPMC resulted better product, higher moisture retention and lower oil uptake than the French fries with other hydrocolloids (CMC and xanthan gum).The sensory attributes of these French fries treated with HPMC were better than with the other hydrocolloids.*

KEYWORDS: *French fries, hydrocolloids, Pretreatments, oil uptake, sensory parameters*

I. INTRODUCTION

Awareness of adverse effects of excessive dietary fat intake is virtually universal. Consequently, health conscious individuals are modifying their dietary habits and eating less fat (Miller and Groziak, 1996). Consumer acceptance of any food product depends upon taste which is the most important sensory attribute. Although consumers want food with minimum to no fat or calories, they also want the food to taste good. Because several food items formulated with fat replacers do not compare favorably with the flavor of full-fat counterparts, it is difficult for some people to maintain a reduced fat dietary regime. Food manufacturers continue to search for the elusive “ideal fat replacer” that tastes and functions like conventional fat without the potential adverse health impact.

Rationale for Fat Replacers : As a food component, fat contributes key sensory and physiological benefits. Fat contributes to flavor, or the combined perception of mouth feel, taste, and aroma/odor (Ney, 1988). Fat also contributes to creaminess, appearance, palatability, texture, and lubricity of foods and increases the feeling of satiety during meals. Fat can also carry lipophilic flavor compounds, act as a precursor for flavor development (e.g., by lipolysis or frying), and stabilize flavor (Leland, 1997). From a physiological standpoint, fat is a source of fat-soluble vitamins, essential fatty acids, precursors for prostaglandins, and is a carrier for lipophilic drugs. Fat is the most concentrated source of energy in the diet, providing 9kcal/g compared to 4kcal/g for proteins and carbohydrates. High fat intake is associated with increased risk for obesity and some types of cancer, and saturated fat intake is associated with high blood cholesterol and coronary heart disease (AHA, 1996; USDHHS, 1988). The 1995 Dietary Guidelines (USDA ,USDHHS, 1995) recommend limiting total fat intake to no more than 30% of daily energy intake, with saturated fats no more than 10% and mono unsaturated and poly unsaturated fats accounting for at least two-thirds of daily energy intake. Consumer surveys indicate that 56% of adult Americans try to reduce fat intake and many show interest in trying foods containing fat replacers (Bruhn et al., 1992). A survey conducted by the Calorie Control Council (CCC, 1992) found that 88% of adults reported consuming low-fat, reduced-fat or fat-free foods and beverages (CCC, 1996). Although fat intake is declining, probably due to the increased availability of low and reduced-fat products and lean meats, fat consumption is greater than the recommended levels, and the prevalence of the population classified as overweight is increasing (Frazao, 1996). Foods formulated with fat replacers are enjoyable alternative to familiar high-fat foods. By choosing these alternative foods, health conscious consumers are able to maintain basic food selection patterns and more easily adhere to a low-fat diet (CCC, 1996). Fat may be replaced in food products by traditional techniques such as substituting water or air for fat, using lean meats in frozen entrees, skim milk instead of whole milk in frozen desserts, and baking instead of frying for manufacturing or preparing snack foods (CCC, 1992). Fat may also be replaced in foods by reformulating the foods with lipid, protein, or carbohydrate-based ingredients, individually or in combination. Fat replacers represent a variety of chemical types with diverse functional and sensory properties and physiological effects.

French Fries : ***French fries*** (American English) or **chips**, **fries, finger chips**, or **French-fried potatoes** are batons of deep-fried potato. Americans and most Canadians refer to any elongated pieces of fried potatoes as *fries*, while in the United Kingdom, Australia, Ireland and New Zealand, long, thinly cut slices of fried potatoes are sometimes called *fries* to distinguish them from the more thickly cut strips called **chips**.

French fries are served hot and generally eaten as an accompaniment with lunch or dinner, or eaten as a snack, and they are a common fixture of fast food. French fries are generally salted and, in their simplest and most common form, are served with ketchup; in many countries, though, they are topped instead with other condiments or toppings, including vinegar, mayonnaise, or other local specialties. Fries can also be topped more elaborately, as is the case with the dishes of poutine and chili cheese fries. Sometimes, fries are made with sweet potatoes instead of potatoes, are baked instead of fried, or are cut into unusual shapes, as is the case with curly fries, wavy fries, or tornado fries.
French fries contain primarily carbohydrates from the potato (mostly in the form of starch) and fat absorbed during the frying process. For example: A large serving of French fries at McDonald's in the United States is 5.4 ounces (154 grams); nearly all of the 500 calories per serving derive from the 63 g of carbohydrates and the 25 g of fat; a serving also contains 6 g of protein, plus 350 mg of sodium.

II. MATERIALS AND METHOD

Materials

Potatoes- Potatoes are tuberous vegetables used for a variety of Food preparations. French Fries are one of the most popular Food product prepared from Potatoes.

Grinded Sugar- Sugar is a commodity compound used in food processing. ‘Sugar dipping’ may affect the appearance (color) and the shrinkage of potato crisps during frying which may or may not be a detrimental factor. Sugar participates in the Maillard browning during frying (Leszkowiat et al., 1990) and may cause more substantially such reactions in potato crisps. Pre-drying followed by dipping potato crisps in a sugar solution can reduce the oil content of the fried crisps with an increased sweetness

Corn flour- Corn Flour is used during blanching of Fries to improve the texture of French Fries.

Calcium chloride- It Improves moisture retention in fries and also contributes to better sensory attributes in the product. The texture and crispiness in fries is improved.

Vegetable oil- Saffola active oil blended with Rice bran oil (80%) and Soybean oil (20%) with an added advantage of Vitamin E, Oryzanol, Fatty acids with Omega 3 was used for frying the product.

Salt- TATA Low Sodium Salt was used for seasoning of the French Fries.

All the above ingredients were purchased from local market of Amravati.

HPMC- **Hydroxypropyl methylcellulose** (**HPMC**) is an emulsifier, thickening and suspending agent, and an alternative to animal gelatin. Its Codex Alimentarius code (E number) is E464. It is generally recognized as safe by the FDA.

CMC-Carboxymethyl cellulose (CMC) or **cellulose gum** is often used as its sodium salt, sodium carboxymethyl cellulose. CMC is used in food science as a viscosity modifier or thickener, and to stabilize emulsions in various products including ice cream. As a food additive, it has E number E466.

Xanthan Gum is used as a food additive and rheology modifier, commonly used as a food thickening agent (in salad dressings, for example) and a stabilizer (in cosmetic products, for example, to prevent ingredients from separating).

The hydrocolloids such as HPMC, CMC and xanthan gum were gifted from Connell Bros. incorporated on Potato sticks on wet basis.

Method for preparation of French Fries : Wash the potatoes thoroughly to remove the soil on it. Then peel the potatoes with a peeler. Now cut the potatoes with a French Fries Cutter in the form of sticks of size 7x1cm.Transfer these sticks in a water bowl so as to avoid enzymatic browning. Warm the same amount of water (amount of water in which fries were dipped) up to 80ºC. Add 2gms grinded sugar, 0.5% aqueous solution of $CaCl_2$ and 2gms of Corn flour in this hot water. Soak the previously dipped sticks in this hot water solution for 7mins for blanching. Meanwhile, warm 100ml of water up to 90ºC. Add 1gm of HPMC in this water and mix this thoroughly so that an even solution is formed. Same procedure was followed for other hydrocolloids such as CMC and Xanthan gum. Then these sticks were dipped in the hydrocolloids solution, for 2-3min so that a layer of hydrocolloid is formed on the surface of the sticks. Then the sticks were removed and frozen for about 20mins at 0ºC.After 20mins sticks were fried in hot oil (160ºC for 2-3min).Then the fries were removed from the fryer and kept at room temperature for 2mins.Again these sticks were fried at 160ºC for 7mins.Then the fries were removed from the fryer and excess oil on the surface of sticks was soaked out with the help of a tissue paper, followed by salt addition and tossing them to mix the salt evenly. The same procedure was followed for other hydrocolloids for concentrations of 0.5%, 1% and 1.5% solution. All other parameters were kept same. The fries were allowed to cool and used for analysis of oil uptake and sensory quality. The frying was carried out in the fresh refined oil at every time. The method of preparation of French Fries is shown in figure1.

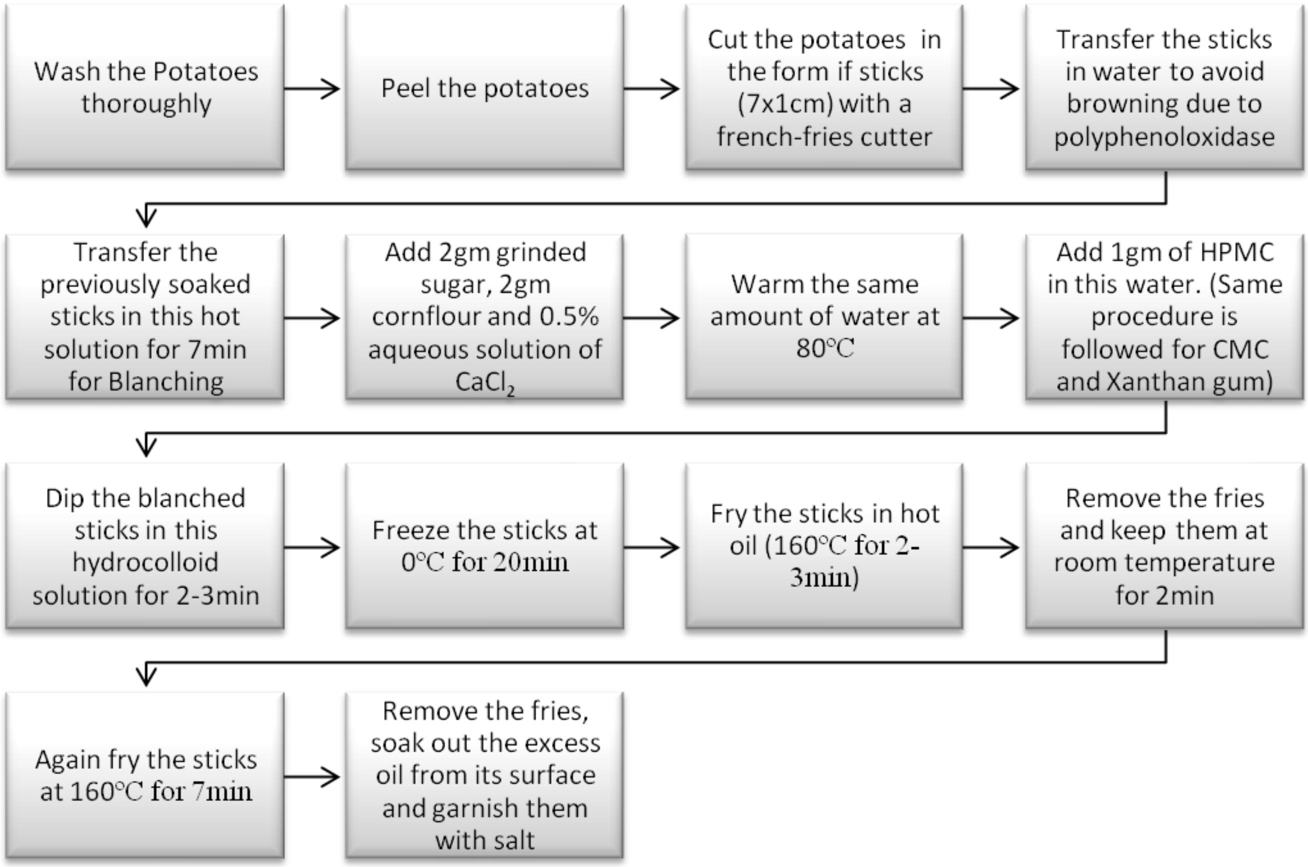

Figure 1: Method for preparation of French Fries

Physico-chemical and sensorial analysis of French Fries

Oil content : Oil Content was determined by using Soxhlet method (AOAC, 2002) using the Pelican Soxhlet apparatus.

Moisture Content : The Moisture Content was determined using RADWAG Moisture analyzer.

Sensory Quality
The Fries were evaluated for sensory quality by using the Hedonic method. Attributes like appearance, aroma, taste, mouth feel, bite and overall acceptability were evaluated by a semi trained panel of 7 judges on 9 point Hedonic scale (1- extremely dislike, 9- extremely like) suggested by Amerine et al. (1965).

III. RESULT AND DISCUSSION

Moisture loss and oil uptake : The data on moisture and oil contents of French fries revealed that the product when pretreated with 0.5% aqueous solution of$CaCl_2$andcoated with 1% aqueous solution of HPMC retained highest moisture (36.23%) in the product. It is known that the HPMC forms a film on the product and decreases the tendency of the product to absorb the oil and lose moisture. The mass transfer ceases to occur. The oil content of French fries decreased considerably with pretreatments and addition of hydrocolloids, irrespective of the type of hydrocolloids as compared to control. In the present study this holds good and French fries retained more moisture and taken up less oil. The moisture retention of control was lowest (28.10%) than any of the other samples which indicated that it was only pretreated with hot water and not coated with any of the hydrocolloids and sufficient mass transfer might have occurred. One of the most important properties of hydrocolloids is their ability to form films and sheets and act as a very effective barrier to oil and therefore used in number of food applications including adhesion, film forming, thermal gelling and non-charring characteristics. The film forming characteristics of these hydrocolloids have prevented the absorption of oil and at the same time helped to retain the natural moisture of foods. This could be the reason of using these hydrocolloids in deep frying of fried products (Ang, 1993; Koelsch and Labuza, 1992; Mallikarjunan *et al.*, 1997; Williams and Mittal, 1999; Sakhale *et al.*, 2011).

1) The addition of **HPMC** in French Fries was varied from 0.5, 1.0 and 1.5% and corresponding oil uptake was observed and is reported in Table 1. From the Table we see that the moisture content (36.23%) was highest on the addition of 1.5% HPMC followed by 1% and then 0.5%. Also, the oil content during 1.5% HPMC (13.02) was the least as compared to control (23.60%) followed by 1% and 0.5% HPMC. From the observations we could conclude that the best results were found during the addition of 1.5%HPMC in the French Fries with the reduction in oil uptake up to 44.83%.

Table 1: Effect of levels of HPMC on oil uptake of French Fries.

Hydrocolloids	Levels of Addition (%)	Moisture Content (%)	Oil Content (%)	% Reduction in oil uptake
Control		28.10	23.60	
HPMC	0.5	32.21	15.54	34.15
HPMC	1.0	34.73	14.12	40.16
HPMC	1.5	36.23	13.02	44.83

2) The addition of **CMC** in French Fries was varied from 0.5, 1.0 and 1.5% and corresponding oil uptake was observed and is reported in Table 2. From the below Table we see that the moisture content (33.26%) was highest on the addition of 1.5% CMC followed by 1% and then 0.5%. Also, the oil content during 1.5% CMC (16.71) was the least as compared to control (23.60%) followed by 1% and 0.5% CMC. From the observations we conclude that the best results were found during the addition of 1.5% CMC in the French Fries with the reduction in oil uptake up to 29.19%.

Table 2: Effect of levels of CMC on oil uptake of French Fries.

Hydrocolloids	Levels of Addition (%)	Moisture Content (%)	Oil Content (%)	% Reduction in oil uptake
Control		28.10	23.60	
CMC	0.5	30.04	20.25	14.19
CMC	1.0	31.92	18.38	22.11
CMC	1.5	33.26	16.71	29.19

3) The addition of **Xanthan Gum** in French Fries was varied from 0.5, 1.0 and 1.5% and corresponding oil uptake was observed and is reported in Table 3. From the Table we see that the moisture content (35.49%) was highest on the addition of 1.5% Xanthan Gum followed by 1% and then 0.5%. Also, the oil content during 1.5% Xanthan Gum (15.20) was the least as compared to control (23.60%) followed by1% and 0.5% Xanthan Gum. From the observations we conclude that the best results were found during the addition of 1.5% Xanthan Gum in the French Fries with the reduction in oil uptake up to 35.59%.

Table 3: Effect of levels of Xanthan gum on oil uptake of French Fries.

Hydrocolloids	Levels of Addition (%)	Moisture Content (%)	Oil Content (%)	% Reduction in oil uptake
Control		28.10	23.60	
Xanthan gum	0.5	31.71	17.30	26.69
Xanthan gum	1.0	33.90	16.56	29.83
Xanthan gum	1.5	35.49	15.20	35.59

Sensory quality of French Fries

The sensory quality is an important aspect in considering the overall acceptability of food product. Deep fat frying is widely used in industrial preparation of foods, because consumers prefer the taste, appearance and texture of fried food products (Saguy and Pinthus 1994). The French Fries prepared by addition of various hydrocolloids in varied levels were subjected to sensory evaluation for various quality parameters like color, aroma, taste, mouth feel and overall acceptability by semi trained panel of seven judges using nine point hedonic scales. The sensory scores obtained with respect to various quality attributes were statistically analyzed and presented in Table 4. The results on sensory quality of French Fries with different hydrocolloids showed that coating with HPMC at1% level was found superior in quality with respect to overall acceptability as compared to all other hydrocolloids. This treatment was followed by xanthan gum at the same level. The French Fries with CMC scored poorly with respect to sensory quality. It is reported that hydrocolloids are used 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, improve their eating quality and appearance (Kotoki and Deka 2010; Kohajdova and Karovicova 2009).

Table 4: Effect of levels of hydrocolloids on sensory quality of French Fries.

Hydrocolloids	Levels of Addition (%)	Appearance	Aroma	Taste	Mouth feel	Bite	Overall-acceptability
Control		9	9	8	8	8	8.5
HPMC	0.5	8	7	7	6	7	7
HPMC	1.0	8	8	8	7	8	8
HPMC	1.5	8	7	6.5	6	6	6
CMC	0.5	7	7	6	6.5	6	6
CMC	1.0	7	7	6.5	6.5	6	6.5
CMC	1.5	7	7	6	6	6	6
Xanthan gum	0.5	8	7	6.5	6	6.5	6.75
Xanthan gum	1.0	8	8	7	7	8	7.5
Xanthan gum	1.5	8	7	6	6	6	6.5

IV. CONCLUSION

Among all the hydrocolloids studied at different levels for preparation of French Fries, it can be concluded that potato French fries pretreated with 0.5% calcium chloride and coated with 1% HPMC were found statistically significant over all other hydrocolloids in oil uptake with optimum sensory quality characteristics. Thus, French Fries with low fat and low calorie content with better acceptance can be prepared in order to meet the demand of low fatty foods of health cautious consumers.

REFERENCES

[1]. AHA. Dietary guidelines for healthy Americans. Circulation, 94: 1795-1800, 1996.
[2]. Amerine M. S., Pangborn R. M., Roessler E A. Principles of sensory evaluation of foods. Academic, New York, 1965.
[3]. Ang, J. F. Reduction of fat in fried batter coatings with powdered cellulose, Journal of the American Oil Chemists' Society 70: 619-622, 1993.
[4]. Annapure U.S., Singhal R.S., Kulkarni P.R. Studies on deep-fat fried snacks from some cereals and legumes, J Sci Food Agric76:377–382, 1998.
[5]. Bruhn, C.M., Cotter, A., Diaz-Knauf, K., Sutherlin, J., West, E., Wightman, N., Williamson, E. and Yaffee, M. Consumer attitudes and market potential for foods using fat substitutes, Food Technol. 46(4): 81-86, 1992.
[6]. C.C.C., "Fat Replacers: Food Ingredients for Healthy Eating," 12 pp., Calorie Control Council, Atlanta, Ga, 1992.
[7]. C.C.C., "Fat Reduction in Foods," 111 pp., Calorie Control Council, Atlanta, Ga, 1996.
[8]. Das M. N., Giri N.C., Design and analysis of experiments, 2ndedn. Wiley Eastern Ltd, New Delhi, 1988.
[9]. Feeney R.D., Haralampu S.G., Gross A.T., Potato and other food products coated with edible oil barrier films, US Patent 5:217–736, 1993.
[10]. Frazao, E., The American diet: A costly health problem, Food Review, Jan.-Apr. pp. 1-6, 1996.
[11]. Gamble M.H., Rice P. Effect of pre-frying drying on oil uptake and distribution in potato crisp manufacture, Int J Food Sci. Technology 22:535–539, 1987.
[12]. Holikar M., Annapure U.S., Singhal R.S., Kulkarni P.R.,.Pectin and calcium chloride treatment for low-fat green gram splits, J Sci Food Agric 85:1677–1680, 2005.
[13]. Indira T.N., Baby Latha R, Prakash M. Kinetics of deep- fat –frying of a composite product, J Food Sci Technol 36:310–315, 1999.
[14]. Kimber M.P., Holding S., Some technological aspects of batter. In: 1st European Symposium on Savory Coatings, Elsevier Applied Science Publishers LTD, London, pp 85–89, 1987.
[15]. Koelsch, C., Labuza. Edible water vapor barriers: properties and promise, Trends in Food Science and Technology 5: 76-81, 1992.
[16]. Kohajdova, Z. and Karovicova, J. Application of hydrocolloid as baking improvers, Chemical Papers63: 26-38, 2009.
[17]. Kotoki, D. and Deka, S.C. Baking loss of bread with special emphasis on increasing water holding capacity, Journal of Food Science and Technology 47:128-131, 2010.
[18]. Leland, J.V. Flavor interactions: The greater whole, Food Technol. 51(1): 75-80, 1997.
[19]. Leszkowiat, M. J., Baricello, V., Yada, R. Y., Coffin, R. H., Lougheed, E.C., & Standley, D. W. Contribution of sucrose to non-enzymatic browning in potato chips, Journal of Food Science, 55, 281–282, 1990.
[20]. Mallikarjunan, P., Chinnan, M.S., and Balsubramanium,V.M., Edible coatings for deep fat frying of starchy products, Journal of Food Science and Technology 30: 709 -714, 1997.
[21]. Miller, G.D. and Groziak, S.M., Impact of fat substitutes on fat intake, Lipids 31(S): 293-296, 1996.
[22]. Ney, K.H., Sensogamme, einemethodische Erweiterung derAromagramme, Gordian 88(1): 19, 1988.
[23]. Saguy, I.S. and Pinthus, E.J., Oil uptake during deep fat frying: Factors and Mechanisms, Food Technology 49 (4): 142-145,152, 1994.
[24]. Saha D., Bhattacharya S. Hydrocolloids as thickening and gelling agents in food: a critical review, J Food Sci Technol 47:587–597, 2010.
[25]. Sakhale, B. K., Badgujar, J. B., Pawar, V. D. and Sananse S. L., Effect of hydrocolloids incorporation incasing of samosa on reduction of oil uptake, Journal of Food Science and Technology (Online) DOI: 10.1007/s13197-011-0333-0, 2011.
[26]. USDA and USDHHS. Nutrition and your health: Dietary guidelines for Americans. 4th ed., Home and Garden Bulletin, No. 232, U.S. Dept. Agriculture and U.S. Dept, Health and Human Services, Washington, D.C, 1995.
[27]. USDHHS. "The Surgeon General's Report on Nutrition and Health. Publ. No. 88-50210. U.S. Govt. Print. Office, Washington, D.C, 1988.
[28]. Varela G., Current facts about the frying of foods. In: Valera G, Bender A.E., Morten J.D., (ed) Principles, changes, new approaches.UK, pp 9–25, 1988.
[29]. Williams, R. and Mittal, G. S. Low fat fried foods with edible coatings: modeling and simulation, Journal of Food Science 64: 317-322, 1999.