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Carboxymethylcellulose and hydroxypropylmethylcellulose as additives in reduction of oil content in batter based deep-fat fried boondis

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Studies on boondi, a deep fried batter based legume snack food popular in the Indian sub-continent were conducted to reduce oil content. Effects of varying the water levels in the batter on the shape of the resulting boondi were noted. The effects of incorporating carboxymethyl cellulose (CMC) and hydroxypropylmethyl cellulose (HPMC) in the bengal gram flour on the water levels so as to get appropriate batter viscosity for getting round shaped boondi were also recorded. The addition of 2% CMC and 1% HPMC (based on weight of bengal gram flour) in the dough decreased oil content in the fried boondi by 26.2% and 22.7% respectively as compared to the control. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

Fried foods form an integral part of diet all over the world, and are based on a variety of ingredients such as cereals, legumes, cereal/legume blends, potatoes and bananas. Boondi, a popular food product of the Indian sub-continent is made by dropping the batter of bengal gram through sieves into the frying fat followed by deep fat frying. Boondi is used in salted form in snacks and savouries as well as a sweet preparation after binding it in a sugar syrup.

In recent years, the importance of restriction of dietary fats is well recognized. Since fried foods are concentrated sources of fat, reducing oil content of these products is of interest to researchers. The simplest and most convenient method which does not require variation in the equipment design is the use of additives to reduce the oil content. Addition of soy flour to donuts (Johnson, 1970; Martin & Davis, 1986), amylose starch binder in French fries (Cremer, 1978), use of film forming agents such as gelatin or certain starches (Olson & Zoss, 1985), and various powdered cellulose derivatives (Pinthus *et al.*, 1993; Henderson, 1988) as well as alginates (Pinthus *et al.*, 1993) have been used to limit the fat uptake of fried foods. CMC has been employed in various batters and coatings as an oil barrier during deep fat frying (Keller, 1986), while HPMC functions by virtue of its film, forming ability and thermal gelation at high temperatures. Dipping blanched and dewatered potato pieces in a solution of HPMC prior to deep fat frying is reported to give less greasy French fries and improve cooking economy reducing oil losses (Grover, 1986). However, the mechanisms of frying are poorly understood, and additives which work well to reduce the oil uptake in one food may not necessarily apply in another product having a different chemical composition. The interactions between the frying fat and the product being fried further complicate this matter.

CMC (Chhaya *et al.*, unpublished work) and Carboxymethyl starch (Bhattacharyya *et al.*, 1995) have been recently shown to reduce oil content in deep fat fried sev, a dough based product. In the present work, use of cellulose derivatives to reduce the oil content in boondi was attempted.

MATERIALS AND METHODS

Bengal gram flour (*Cicer arietnum Linn*), with a moisture content of ~10%, passing through 60 mesh sieve was purchased from a local market in Bombay. The oil used for frying was refined groundnut oil of the brand 'Dhara'.

The boondis were prepared by mixing water into 50 g sifted bengal gram flour to form a batter of appropriate consistency. This batter was dropped through a metallic ladle with circular perforation of about 2 mm diameter into 1000 ml oil heated to 170±5°C. The boondis were fried for 4–5 minutes, then turned and fried for another 45 seconds. The completion of frying was indicated by absence of the steam bubbles generated by the moisture loss from the batter. The product changed from bright yellow to light brown in color with a distinct fried aroma. The samples were cooled and then packed in polyethylene bags and stored in air tight containers until further analysis.

The amount of water added to bengal gram flour to form a batter was varied from 40 to 70 ml so as to optimise the amount of water needed to get round shaped boondis.

The effect of incorporation of CMC (Degree of Substitution = 0.89), and HPMC (methoxyl = 23.7%, propoxyl = 7.0%), both from Aqualon Co., Wilmington, Delaware, USA, in the batter at 0.5, 1.0, 2.0 and 3.0% levels was also studied.

Fresh frying oil was used for each parameter being studied. The fat content of each boondi sample was estimated by using petroleum ether (BP 60–80°C) in a Soxtec apparatus (Tecator, Hoganas, Sweden) in duplicate.

RESULTS AND DISCUSSION

The effect of water content in the batter on the shape of boondis is as shown in Fig. 1. It can be seen clearly that to get perfect round boondis, the batter consistency is very critical. At lower levels of water addition, boondis are oblong shaped; whereas at higher water levels, the batter tends to spread in the frying fat, again leading to oblong shaped boondis, with a tail like shape. Water at 56.4 ml per 100 g bengal gram flour was found to give good boondis. The fat content in this product was found to be 41.16%. At higher water levels, frying time was found to be increased by about 5–8 seconds.

The effect of addition of CMC and HPMC at 0.5 to 3.0% levels in the batter necessitated an alteration in the amount of water needed so as to get perfect round boondis. The observations on the amount of water needed for getting proper shaped boondis and the oil content of the resulting boondis are given in Table 1. The shapes of the boondis resulting with these formulations are given in Figs 2 and 3. CMC gave the best results at 2% level with a 26.2% decrease in oil content over the control.

These differences could be hypothetically explained as follows: Oil uptake during frying is a surface phenomenon. An increased hydrophobic character of the surface would result in an increased oil uptake during frying. This has been recently suggested (Pinthus & Saguy, 1994). Similarly the effect of product hydrophobicity is also reported (Blumenthal, 1991). The ability of powdered cellulose to reduce oil uptake in fried foods has been attributed to its hydrophilic character (Ang & Miller, 1991). CMC is known to bind water within the dough (Keller, 1986), thus maintaining its hydrophilicity and preventing oil penetration. A reduced surface tension between oil and water also causes an increase in oil absorption (Mohamed *et al.*, 1995). Addition of CMC to bengal gram batter probably increases the surface tension, and hence causes a reduction in oil absorption. The increase in oil content

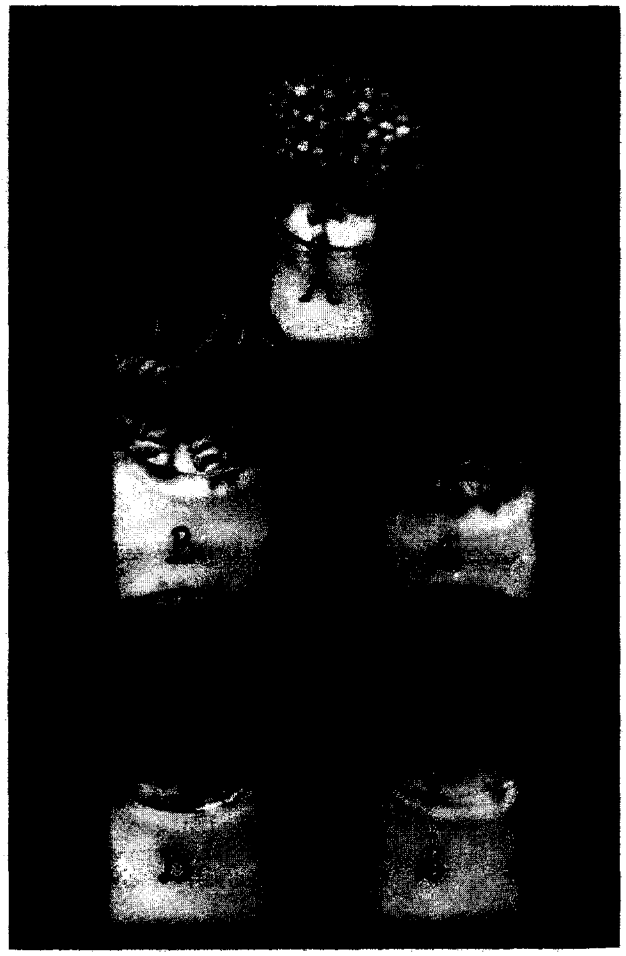

Fig. 1. Effect of water level in the batter on the shape of boondis using (A) 54.6ml, (B) 40.0ml, (C) 50.0ml, (D) 60.0ml, and (E) 70ml for 50g bengal gram flour

Table 1. Effect of incorporation of CMC and HPMC on the water required in the batter for appropriate consistency and the oil content[a] of the resulting boondis

Additive used	Water required for the batter (ml)	Oil content (%)	% Reduction
Nil control	54.6	41.16	—
0.5% CMC	64.0	35.18	14.53
1.0% CMC	72.0	31.77	22.81
2.0% CMC	74.4	30.38	26.19
3.0% CMC	79.0	43.24	−5.05
0.5% HPMC	70.0	35.57	13.58
1.0% HPMC	80.4	31.80	22.74

[a]Average of two determinations.

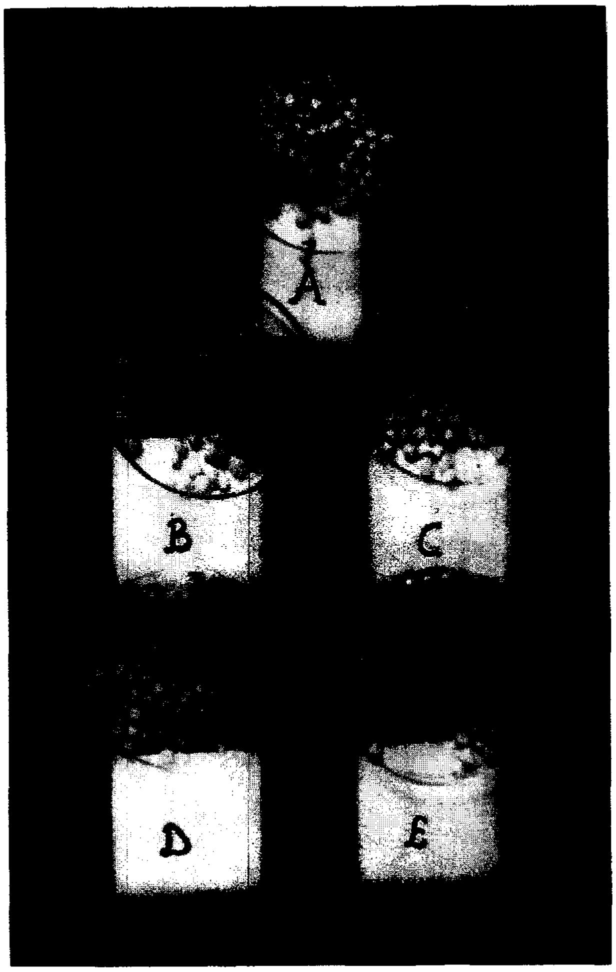

Fig. 2. Shape of boondis after water adjustment using: (A) control, (B) 0.5% CMC, (C) 1.0% CMC, (D) 2.0% CMC, and (E) 3.0% CMC.

at levels higher than 2% requires further investigation for better understanding. HPMC at 1% level decreased oil content by 22.7% compared to the control. Boondis could not be prepared with HPMC above 1% level since it forms a mat like structure in the frying fat, due to its tendency to gel at 85°C. The differences in the behavior of HPMC and CMC could be due to their interaction with substrate ingredients such as proteins and polysaccharides, and requires clearer understanding.

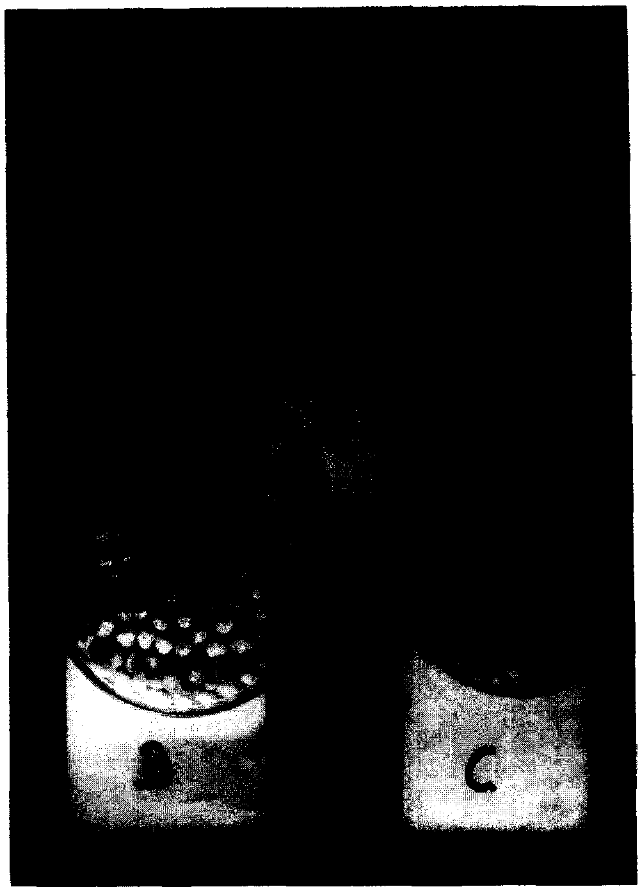

Fig. 3. Shape of boondis after water adjustment using: (A) control, (B) 0.5% HPMC, and (C) 1.0% HPMC.

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