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Technical Note

Storage Related Changes in Flavour and Certain Chemical Characteristics of a Soy-Based Spread

ABSTRACT

An oil-in-water type low-fat spread based on a soy protein–lipid concentrate and vegetable fat was subjected to accelerated and regular storage studies. Shelf stability of the spread was substantially enhanced by the use of preservatives such as benzoic acid, sorbic acid and potassium sorbate. The level of preservative was found to be more important than the type of preservative, 0·1% being more effective than 0·05%. The spread containing sorbic acid and potassium sorbate retained an acceptable flavour for 10 weeks at 5°C. There was no significant difference between glass jars and tin cans as containers for the spread. Flavour changes in the product exhibited definite correlation with development of acidity, free fatty acids and non-protein nitrogen.

INTRODUCTION

The advent of low-fat spreads in recent times is largely due to their functional superiority to the traditional table spread, butter. Falling consumption of butter in many countries in Europe and North America has been ascribed also to its high calorie content and low polyunsaturated fatty acid content. However, the major limitation with spreads is their short shelf life, often only a few weeks (Kozin & Rebrina, 1974; Stamenov, 1979). Principally limited by microbial spoilage, storage stability of these high-moisture products is influenced by factors such as pH and the size of serum droplets dispersed in the continuous fat phase in the case of water-in-oil

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(W/O) emulsions (Bullock & Kenney, 1969; Madsen, 1976), and pH, water activity and heat-treatment for oil-in-water (O/W) type spreads (Kreisman & Labuza, 1978; Kosikowski, 1982). Appropriate heat-treatment (Rasic *et al.*, 1978; Modler *et al.*, 1985) and use of preservatives (Spurgeon *et al.*, 1970; Guy *et al.* (1972) have been suggested to impart reasonable shelf stability to O/W spreads.

The studies cited above pertain to non-soya spreads. No information is available on storage life of soy-based spreads although manufacture of such products has been frequently reported in the literature. The present paper discusses the flavour acceptability and certain chemical properties of an O/W low-fat spread prepared from a soy concentrate and vegetable fat during storage under various conditions.

MATERIALS AND METHODS

Spread preparation, packaging and storage conditions

The method of preparation of the soy-based spread (Patel & Gupta, 1986) consisted in blending of soy protein–lipid concentrate with skimmed milk powder, vegetable fat, sodium citrate (1%), guar gum (0·1%), salt (1%), sorbitol (1%), flavouring (diacetyl-based) and colouring (butter annatto + β-carotene), then heat-processing (90°–95°C for 10–15 min), acidulating to pH 6·0–6·2, adding preservatives and finally grinding in a colloid mill before packaging hot. The spread contained, on average, 46·6% moisture, 39·4% fat and 6·3% protein.

Wide-mouthed screw-capped glass jars (capacity, 200 ml) were used for accelerated storage studies at 17° ± 1°C, and glass jars as well as 200 ml sealed lacquered tin cans for regular storage at 5° ± 2°C. Prior to use, glass jars and tin cans were sterilized in an air-oven at 110°C for 3 h and the plastic screw caps were sterilized in chlorine solution (300 ppm) for 5 min and wiped dry with a sterile cotton swab. For storage at the higher temperature, the packaged product was directly transferred to the incubator, whereas it was held at the ambient temperature for 6–8 h before being transferred for storage at 5°C. The preservatives investigated were sorbic acid, potassium sorbate (SD's Lab-Chem, India) and benzoic acid (Polypharm, India).

Analytical methods

Titratable acidity was determined by dispersing a 10 g sample in 20 ml warm distilled water (45°C) and titrating with 0·1N sodium hydroxide using phenolphthalein as indicator. Determinations of free fatty acids (Thomas *et*

al., 1954), non-protein nitrogen (Becker *et al.*, 1940) and peroxide value (Smith, 1939) were made on freeze-dried (Virtis, USA) samples (moisture, 2·0% or less). pH of the spread slurried in warm water (45°C) was determined with a digital pH meter (Digital Instruments Corp., India). Water activity was estimated as per the method of Lang & Steinberg (1981).

Sensory evaluation of the stored product for its flavour was carried out by a panel of seven judges selected from among the staff of the Division. A special laboratory providing the necessary environment and other facilities was used for this purpose. Flavour scores were obtained on a nine-point scale ranging from 1 (extremely undesirable) to 9 (most desirable). Descriptive terms used by the panellists, under the column 'Remark', were taken to characterize quality changes in the product. Differences between sample means ('*t*'-test) and coefficients of correlation between flavour score and chemical parameters were worked out according to Amerine *et al.* (1965).

RESULTS

Preliminary observations

Heat-treatment of the spread at 85°C for 10 min resulted in a shelf life of not more than a few hours at the room temperature (25–30°C). However, heating at 90–95°C for 10–15 min rendered the product shelf-stable for a few days at the ambient temperature and a few weeks at the refrigeration temperature (5–8°C). Further, acidification to pH 5·5 or lower (from initial 6·5) adversely affected the flavour and texture of the spread.

During accelerated (17°C) storage studies on the jar-packed product, the flavour score tended to decline, particularly after 3 days, although the decline was slower in samples containing preservatives (Fig. 1). At the 0·05% level of addition, sorbic acid was slightly more effective in retarding the spoilage than benzoic acid. A total preservative concentration of 0·1% obtained by combined addition of any two of the preservatives had a greater impact than 0·05% of any one of them. However, the two combinations studied did not differ significantly in their preserving effect. Moreover, the control, unlike the product containing preservatives, became mouldy with its surface discolored after 7 days, though all the samples were unacceptable at this stage.

Regular storage

The spread containing sorbic acid and potassium sorbate, 0·05% each, and stored at 5°C for a period of 6 months exhibited a gradual decrease in the

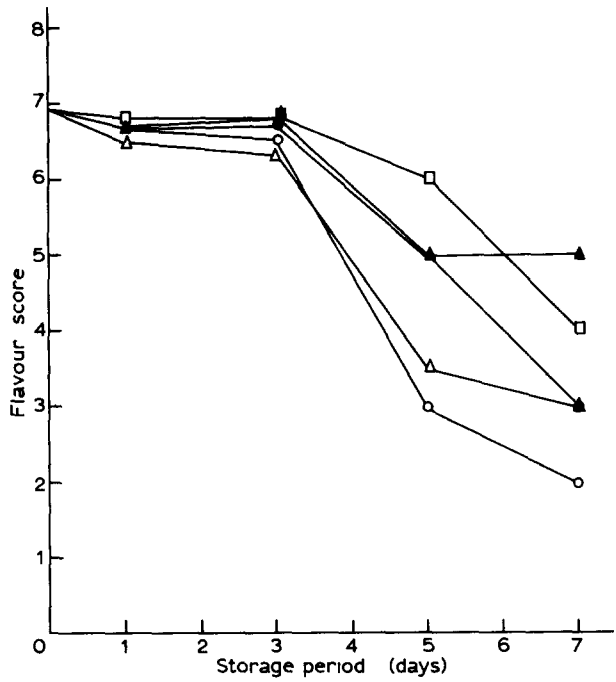

Fig. 1. Effect of preservatives on the flavour score of soya spread stored at 17°C: ○—control; ●—sorbic acid, 0·05%; △—benzoic acid, 0·05%; ▲—sorbic acid, 0·05% + benzoic acid, 0·05%; □—sorbic acid, 0·05% + potassium sorbate, 0·05%.

flavour score during the first few weeks followed by a rapid decline after 8 weeks (Table 1). The 'buttery' flavour was perceptibly diminished after 4 weeks of storage even though no off-flavour was detectable in the product at this time. A slight bitterness was noticed in the spread stored for 12 weeks. Further storage resulted in a continued decrease in the flavour score, the product becoming slightly 'fermented' after 16 weeks and definitely so towards the end of storage, when bitterness also became distinct.

Table 1 further shows that the titratable acidity (TA) increased progressively after remaining almost unchanged for 12 weeks. The free fatty acids (FFA) content of the spread increased rather rapidly after the second week of storage, but subsequently it did not change appreciably. The non-protein nitrogen (NPN) content registered a marginal but nearly steady rise throughout the storage period, its correlation ($P < 0{\cdot}01$) with the flavour score being higher than that of TA ($P < 0{\cdot}01$) or FFA ($P < 0{\cdot}05$).

It was also noted that as containers for the spread, glass jars and tin cans did not exhibit any significant difference as indicated by non-significant ($P < 0{\cdot}05$) 't' values, *viz.*, 0·514, 0·495, 0·421 and 1·730 for flavour score, TA,

TABLE 1
Flavour Score and Related Chemical Parameters of Soya Spread Stored at 5°C[a]

Period of storage (weeks)	*Flavour score*[b]	*Titratable acidity (% lactic acid)*	*Free fatty acids (% oleic acid)*	*Non-protein nitrogen (% in fat-free dry matter)*
0	7·5	0·244	0·240	0·225
2	7·3	0·255	0·265	0·268
4	7·2	0·253	0·413	0·235
6	6·8	0·246	0·435	0·285
8	6·6	0·239	0·365	0·265
12	5·8	0·241	0·423	0·280
16	5·6	0·272	0·420	0·288
20	5·5	0·274	0·410	0·305
24	4·8	0·294	0·450	0·308
r	—	−0·808**	−0·693*	−0·865**

[a] Averages from duplicate experiments.
[b] 1 = extremely undesirable; 9 = most desirable.
r = coefficient of correlation with flavour score.
* Significant at $P < 0·05$; ** Significant at $P < 0·01$.

FFA and NPN, respectively. The figures given in Table 1 thus represent the mean values for the product packaged in jars and cans.

DISCUSSION AND CONCLUSIONS

It was evident from the observations on heat-treatment of the spread that, at ordinary temperatures, the product had a very short shelf life. Its high water activity (0·97) might have accounted for this. While it is recognized that a low pH, usually around 5, is important for satisfactory storage life of spreads of both W/O and O/W types (Velez & Leal, 1973; Hawley, 1977; Kosikowski, 1982), the soy spread could not be acidulated below pH 6·0 without damaging its sensory quality. Hence the shelf stability of this product was thought to be enhanced by means of known antimicrobial agents viz., sorbic acid, benzoic acid and potassium sorbate, which, among other preservatives, have been found useful in similar products (Spurgeon *et al.*, 1970; Velez & Leal, 1973; Grinsted Products, 1978).

Preliminary studies revealed that use of these preservatives, at 0·10% in particular, substantially extended the storage life of the soy spread. The type of preservative had no great influence on the keeping quality of the product. These studies, however, indicate that, for any meaningful storage life, the product must be held at the refrigeration temperature. The spread preserved

with 0·10% sorbic acid + potassium sorbate could store well for at least 10 weeks at 5°C, the flavour score at the end of such storage being fairly acceptable, i.e. 6·0 or 80% of the initial score (Table 1). Thus it had a better shelf life than that reported by Kozin & Rebrina (1974) and Stamenov (1979) for non-dairy spreads, and was comparable to the reasonably shelf-stable spreads of Spurgeon *et al.* (1970), Rasic *et al.* (1978) and Modler *et al.* (1985).

The decline in the flavour acceptability of the spread could be appreciably correlated with chemical changes. It thus appears that the biochemical changes, presumably brought about by microbial growth in the product, could, to some extent, be monitored by chemical parameters such as TA, FFA and NPN, which largely explain the decrease in the flavour score of the product during storage.

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