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EFFECT OF SOME ADDITIVES AND PACKING MATERIALS ON THE SHELF LIFE OF DRUM-DRIED CARROT POWDER

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Abstract. Effect of addition of BHA, fat and propylene glycol in suitable combinations on the storage life of drum-dried carrot powder as indicated by the β-carotene losses, browning and organolepetic properties was studied. Also polyethylene coated-paper and poly-coated aluminium-foil bags were tested as packing material for the carrot powder as compared with the tin cans. It was found that addition of fat (0.5% fresh wt. basis) plus BHA to the carrot slurry reduced β-carotene losses and enhanced storage life. Addition of BHA plus propylene glycol had no effect on the loss of β-carotene. Polyethylene coated Al-foil as packing material was found as effective as tin cans while polyethylene-coated paper was suitable only for a short period during dry weather.

In a previous communication [1] it was found that the use of rice flour and potassium metabisulphite is beneficial for the production of carrot powder. Also it was found that oxidative changes caused some off-flavours in the powder during storage and hence the use of some antioxidant to increase the shelf-life of the powder was suggested. The present studies were conducted to investigate the effects of BHA, fat and propylene glycol on the shelf-life of drum-dried carrot powder. The use of polycoated aluminium (Al) foil and polycoated paper as the packing material was also tested as the previous investigation showed polyethylene and poly + paper carton to be unsuitable packing materials for the carrot powder.

Materials and Methods

Fresh carrots of red variety were obtained from the local market. After proper washing, cleaning and slicing the carrots were blanched in live steam as described previously.[1] The blanched carrots were divided into three portions and treated as under:

Sample A (control). Rice flour and potassium met-metabisulphite (KMS) were added at 2.5 and 0.05% of carrots respectively. KMS was added in the form of solution (1%).

Sample B (BHA + Fat): Vegetable fat (dalda) containing 0.025% BHA was added at 0.5% of the carrots (w/w) to the control sample.

Sample C (BHA + Propylene Glycol): Propylene glycol (PG) containing 0.025% BHA was added at 0.5% of carrots (v/w) to the control sample.

Carrots and added ingredients were well mixed in a Hobart food chopper to get a uniform slurry. The slurry was then drum-dried on a locally fabricated drum-dryer at 10 rev/min, steam pressure 15 lb/in^2 and distance between the drums, 0.01 in. The dried samples with moisture content around 7%, were then dried to a moisture content of about 5% in an oven at 104—105°F. The dry carrot powder from each treatment was packed in: (a) polyethylene bags placed inside tin-cans which were then sealed hermetically; (b) polyethylene-coated paper bags; and (c) polyethylene-coated aluminimum foil bags. The packaged samples were stored at room temperature (20-30°C) for a period of six months and ana.ysed for moisture, β-carotene and browning after an interval of 2 months. Organoleptic tests were also performed after every 2 months.

Measurement of Browning. Browning was measured by the method of Gooding *et.al*; 1 g sample was taken in a 50-ml test tube and brown pigments were extracted with 25 ml, 50% ethanol with occasional stirring. After 24 hr the material was filtered and browning was measured in the filtrate as optical density (O.D.) at 420 nm in sillica cells of 1-cm ligh path using ethanol (50%, (v/v) as blank.

Estimation of β-Carotene. β-Carotene was measured essentially by the method described by Kramerer and Fraps.[3] Dry carrot flakes (0.5 g) were - ground with sand and 40 ml of a mixture of acetone and petroleam ether, 1 : 1(v/v, b.p. 60-80). The material were filtered and the filtrates washed with distilled water (3×15 ml) to remove acetone. The ether layer was mixed with Na_2SO_4 to remove traces of moisture before diluting it to 25 ml with dry petroleum ether. The diluted extract (10 ml) was chromatographed on an alumina column and the β-carotene estimated spectrophetometerically in the eluate.

Organoleptic Evaluation. A sweet dish was prepared from the powder and presented to a panel of judges for taste evaluation. Judges were asked to score the quality as good, satisfactory or poor according to their liking for colour, consistency and taste of the dish. The dish was prepared by mixing 60 g carrot powder and 100 g sugar in 1 litre milk and boiling the slurry for 10 min. The dish was cooled and presented to the panel for evaluation.

Moisture was determined according to A.O.A.C. method.[4]

Accelerated Moisture Penetration Tests. Control carrot power samples weighing 25 g were packed in tressi bags prepared from (a) polycoated Al-foil; (b) polycoated paper and (c) waxed paper. The bags were then placed in humidity chamber for water vapour permeability tests at the following conditions: relative humidity (R.H.), 90%, and temperature, from the chamber and tested for moisture take-up. Mathematically moisture take-up was expressed as below:

$$\text{Moisture take-up (\%)} = \frac{\text{increased in weight} \times 100}{\text{Original weight}}$$

Results and Discussion

Percent β-carotene losses in carrot powder containing different additives and packed in different packing materials are shown in Table 1. It was found that addition of BHA + propylene glycol did not reduce the carotene losses. For example the control sample (A) and the one containing BHA + propylene glycol (sample C) both stored in tin cans, both 68.9 and 71.2% P-carotene respectively during 6-month storage at room temperature. Addition of BHA + fact however, was found to reduce β-carotene losses (Table 1). Figure for β-carotene losses for sample containing BHA fat (sample B) are 60.5, 66.5 and 61.4% in case of three different packing materials used as compared to 68.9, 75.5 and 69.2% for control sample (A).

It is clear that combined use of BHA + propylene glycol is ineffective in controlling β-carotene losses as was found by Bhatia *et.al.*[5] Fat+BHA, however, are effective. The actual mode of action of fat is not clear, however, it seems that fat acts indirectly, i.e. it dissolves the BHA and carries it where the carotenoid containing lipid fractions are. Fat might have some protective action of its own as was indicated by Bhatia *et al.*[5] But in the absence of experimental data collected by us the latter mode of action cannot be emphasized.

Packing Materials. Packing materials had significant effect on β-carotene retention in carrot powder (Table 1). Polyethylene + tin cans and poly + Al-foil appeared equally effective in controlling carotene losses. Poly-coated paper bags were found to be inferior to other packing materials as the β-carotene losses were highest (upto 75.5% in case of sample A) for all the samples packed in the said bags. Polycoated paper is not a suitable packing material as is clear from the tremendous increase in moisture content during storage for 6 month (Table 2). Moisture content of control sample, packed in polycoated increased from 4.7 to 9.0%, i.e. an increase of 91.0% within six months whereas this increase was not appreciable in case of other two packing materials. Accelerated moisture penetration tests also showed that sample packed in polycoated paper had 13.9% moisture takeup within 10 days as compared to 1.33% in the case of the sample packed in Al-foil.

Browning. It was found that an appreciable browning took place only in the samples packed and stored in poly coated paper bags (Table 3). This is understandable in view of the fact that these samples gained moisture during storage and it is established that rate of browning in dehydrated vegetables is a function of the moisture content.

Organoleptic Tests. Organoleptic tests showed that all the samples were perfectly good during first two months of storage but the quality began to deteriorate after that period in case of some samples (Table 4). BHA and fat-treated samples were good even after 4 months storage except for the sample packed in polycoated paper. It was noticed, however, that after 6-month storage under ambient conditions all the samples were scored as satisfactory except the sample A (control) and C (BHA+PG-treated) packed in polycoated paper bags which were scored as poor. Again this indicated that polycoated paper is not a good packing material for dehydrated carrot powder.

Conclusions

Considering overall results it is concluded that: (i) Addition of BHA +propylene glycol has no effect in controlling β-carotene losses in carrot powder; (ii) addition of fat + BHA increases the storage-life of carrot powder and reduces carotene losses; (iii) polyethylene in tin can and polycoated aluminum foil are equally effective as packing materials for carrot powder; and (iv) polycoated paper as packing material for carrot powder is only suitable for short period (about two months) during dry weather only.

TABLE 1. LOSSE IN β-CAROTENE DURING STORAGE OF CARROT POWDER CONTAINING SOME ADDITIVES IN VARIOUS PACKING METERIALS AND STORAGE AT ROOM TEMPERATURE.

Sample	Packing material	% Loss during storage (months)		
		2	4	6
(A) Control	Polyethylene in tin cans	30.51	45.30	68.9
	Polycoated paper bags	44.60	52.30	75.5
	Polycoated Al-foil bags	31.30	45.42	69.2
(B) BHA—fat	Polyethylene in tin cans	29.76	44.72	60.5
	Polycoated paper bags	44.23	51.80	66.5
	Polycoated Al-foil bags	30.73	44.66	61.4
(C) BHA—propylene glycol	Polyethylene in tin cans	29.95	45.49	71.2
	Polycoated paper bags	43.66	51.22	78.6
	Polycoated Al-foil bags	31.11	44.85	73.0

*Initial Carotene content, A, 521.0; B 527.0; and C 524.0 on dry basis (mg/kg).

TABLE 2. CHANGE IN MOISTURE-CONTENT OF CARROT POWDER CONTAINING SOME ADDITIVES AND STORED IN DIFFERENT PACKING MATERIALS.

Sample	Packing material	% Moisture in storage time (month)			
		0	2	4	6
(A) Control	Polyethylene in tin cans	4.75	5.00	5.30	5.52
	Polycoated paper bags	4.70	5.20	7.55	9.00
	Polycoated Al-foil bags	4.71	5.10	5.25	5.42
(B) BHA—fat	Polyethylene in tin cans	4.75	4.95	5.12	5.29
	Polycoated paper bags	4.70	5.00	7.54	8.93
	Polycoated Al-foil bags	4.71	5.00	5.00	5.30
(C) BHA—propylene glycol	Polyethylene in tin cans	4.75	4.80	5.10	5.30
	Polycoated paper bags	4.70	5.15	6.52	8.98
	Polycoated Al-foil bags	4.71	5.00	5.13	5.28

TABLE 3. BROWNING OF CARROT POWDER HAVING DIFFERENT PRETREATMENTS AND PACKED IN DIFFERENT PACKING MATERIAL.

Sample	Packing material	Storage time (month)			
		0	2	4	6
(A) Control	Polyethylene tin cans	0.28	0.28(0)	0.30(0.02)	0.31(0.03)
	Polycoated paper bags	0.28	0.29(0.01)	0.32(0.04)	0.38(0.10)
	Polycoated Al-foil bags	0.28	0.30(0.02)	0.30(0.02)	0.32(0.03)
(B) BHA Fat	Polyethylene tin cans	0.30	0.31(0.01)	0.32(0.02)	0.34(0.04)
	Polycoated paper bags	0.30	0.32(0.02)	033(0.03)	0.39(0.09)
	Polycoated Al-foil bags	0.30	0.30(0)	0.31(0.01)	0.33(0.03)
(C) BHA propylene glycol	Polythelyene tin cans	0.28	0.29(0.01)	0.31(0.03)	0.32(0.04)
	Polycoated paper bags	0.28	0.30(0.02)	0.30(0.02)	0.37(0.09)
	Polycoated Al-foil bags	0.28	0.28(0)	0.30(0.02)	0.33(0.05)

Browning expressed as O. D. 420 mu, 1-cm cell thickness; figures in parenthesis indicate extent of browning.

TABLE 4. ORGANOLEPTIC EVALUATION OF CARROT POWDER HAVING DIFFERENT PRETREATMENTS AND PACKED IN DIFFERENT PACKING MATERIAL.

Sample	Packing material	Storage time (month)			
		0	2	4	6
(A) Control	Polyethylene—tin cans	Good	Good	Satisfactory	Satisfactory
	Poly-coated paper bags	"	"	"	Poor
	Poly-coated Al-foil bags	"	"	"	Satisfactory
(B) BHA+fat	Polyethylene—tin canns	"	"	Good	Satisfactory
	Poly-coated paper bags	"	"	Satisfactory	
	Poly-coated Al-foil bags	"	"	Good	
(C) BHA +proplene glycol	Polyethylene—tin cans	"	"	Good	
	Poly-coated paper bags	"	"	Satisfactory	Poor
	Poly-coated Al-foil bags	"	"	"	Satisfactory

Good, tasteful, no off-flavour; satisfactory, tasteful but slight off-flavour; Poor not tasteful, hay-like off-flavour

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