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Suitability of flexible packaging materials for packing mango juice

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SUITABILITY OF FLEXIBLE PACKAGING MATERIALS FOR PACKING MANGO JUICE

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ABSTRACT

Mango Juice was packed and processed in different types of flexible packaging materials. The shelf-life studies for about 10 weeks indicated that mango juice packed in pouch of PET/foil/polyethylene retained ascorbic acid and β-carotene better and the quality was acceptable as compared to the pouches of Met PET/HD-LDPE+PE/HD−LDPE, Met. PET/PE and PET/PE.

Introduction

Research investigations are being carried out in many countries to replace conventional rigid metal and glass containers which are heavy and considered quite expensive compared with the light weight flexible packages for packing of processed food products. A few promising flexible packaging materials which can withstand high processing temperature and pressure have been developed in many advanced countries in recent years. Though, much information regarding the economic benefits of this new packaging method is not available, still it is claimed that these alternative packaging materials are comparatively cheaper than the conventional rigid metal containers

Preliminary work is reported on packaging and preservation studies on pasteurized mango pulp in polypropylene bag (250 g) treated earlier with 900 ppm SO_2. The product could be stored for 3 months at 5°C and for two months at 37°C. There was gradual deterioration in colour and flavour at 22-28°C at the end of 30 days[1].

Concentrated Zebula Mango Juice was packaged in aluminium pouches and stored at 10°F and 40°F for 11 months. Prolonged storage reduced the organoleptic quality and overall acceptability of reconstituted juices, with juice acceptability being lower for the higher storage temperature. Reconstituted Juices were of very good grade for storage at 10 F (−12.2°C) and were of acceptable grade for storage at 40°F (4.4°C).

Mango pulp of variety 'Lucknow Safeda' was stored in polypropylene pouches (200 gauge) with thermal sterilization (T_1) and with 350 (T_2) and 100 (T_3) ppm SO_2, at 32−35°C (ambient) and at 4—6°C. All the samples stored at ambient temperature were spoiled after 2 months, while those stored at lower temperature were in good condition

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after 4 months The treatment 'T_2' was found to be the best preserving mango pulp[3].

Investigations carried out by Gowramma *et al*[1], indicated that two ply laminate pouches of polyester/polyethylene were not found suitable for Packing mango juice.

Keeping the above in view, attempts have been made to find the suitability of different flexible packaging materials for packing mango juice and the results are reported in this paper.

Materials and Methods

Packaging materials : The following four types of stand up pouches were used in these experiments.

1. 12 micron plain polyester/37 micron polyethylene (PET/PE).
2. 12 micron metallised polyester/ 00 micron polyethylene (Met. PET/PE).
3. 12 micron polyester/12 micron aluminium foil/100 micron polyethylene (PET/foil PE).
4. One side 12 micron metallised polyester/ 112 micron HD-LD coextruded and other side 12 micron plain polyester/112 micron HD-LD coextruded (Met. PET/ HD—LDPE+PET/HD—LDPE)

No. 1 tall (301×409) plain can with a differential tincoating of D 100/50 (D 11.2/ 5.6 g/m²) with an outside lacquer coating was used as control.

A. Experimental Procedure :

1. Packing of mango juice : Mango juice was prepared by mixing canned Alphonso mango pulp (15° brix, 0.5% acidity) with sugar, citric acid and water with the following recipe mango pulp : 35%, brix 20° and acidity (as anhydrous citric acid) : 0.3%.

The prepared juice was heated to 85-90°C, filled into pouches/cans, sealed and processed in water at 85°C for 10 min , and cooled in running cold water.

2. Storage conditions : Mango juice packed in flexible pouches and cans were stored under two different conditions, viz , (1) 37°C; (2) ambient temperature (25°—30°C). The samples were withdrawn at the intervals as indicated in Table 2 and analysis was carried out for various physical, chemical, biological and sensory qualities.

B Analytical Methods :

Tensile strength was determined by ASTM D1434[5], water vapour transmission rate (WVTR) by IS 1060[6],—Part II and gas transmission rate (GTR) by IS1060—Part I[7] flexible pouches. Vacuum in the can was determined by piercing type vacuum gauge. Acidity was determined by A.O.A.C. method[8] Total soluble solids were determined using an Abbe refractometer. Total and reducing sugars were determined by Lane and Eynon method[9]. Ascorbic acid was determined by 2, 6-dischlorophenol indophenol dye method[10]. Total carotenoid pigments were determined by modified method as suggested by Susanta Roy[11]. Hydroxy methyl furfural was determined colorimetrically by the method followed by Luh *et. al.*[12].

C. Organoleptic evaluation :

For organoleptic evaluation of mango juice, a numerical scoring scale (5 point scale) was prepared and scores were collected by panelists with respect to colour, odour, taste and overall acceptability of the sample.

The data thus obtained were analysed for analysis of variance and ratio is reported. The scores were then converted to ranks by Hadonic rating method and rank analysis was carried out.

D. Microbiological tests :

Preparation of the samples : Ten ml of the sample was transferred asceptically to 100 ml. of 0.1% peptone water diluent to obtain 1/10th dilution.

1 *Total bacterial count* : One ml of aliquot of suitable dilution was plated using total plate count agar medium and incubated at 37 C ± 0.5 for 48 hours.

2. *Total mould count* : One ml. of aliquot of suitable dilution was plated using potato dextrose agar medium at pH 7.0 and 0.025% chlorotetracycline hydrochloride at room temperature.

3. *Macconkey's broth* : One ml of aliquot was added to 10 ml. of Macconkey's broth in triplicate at 37°C ± 0.5.

Results and Discussion

Packages :

The physico-chemical properties of the four types of flexible laminate pouches used are given in Table 1. Tensile strength for machine direction and transverse direction was more in Met. PET/HD-LD + PET/HD-LD and MET. PET/PE as compared to other packaging materials. Heat seal strength was highest for PET/PE and least for Met PET/HD-LD and PET/HD-LD water vapour transmission rate was high and oxygen transmission rate was very high for PET/PE.

Total soluble solids and acidity :

Total soluble solids and acidity in mango juice packed in flexible packaging materials did not show any change at ambient temperature or at 37°C as in the case of cans (Table 2).

Reducing and total reducing sugars :

The reducing sugar was more in cans as compared to other flexible packaging materials. Regarding total reducing sugars, there was no significant difference between tinplate and flexible packagiag materials (Tab'e 2).

Ascorbic acid :

From the results it is clear that the loss of ascorbic acid in cans during the storage period of 77 days was 18% at room temperature and 24% at 37°C. In the case of flexible packaging materials, the loss of ascorbic acid was less in PET/foil/PE i.e. 44% at RT and 45% at 37°C as compared to Met/PE i.e 46% at RT and 57% at 37°C., during the same storage period. The loss of ascorbic acid in met PET/HD-LD+PET/HD-LD was found to be 46% at RT and 55% at 37°C and in the case of PET/PE it was found to be 71% at RT and 77% at 37°C (Figs. I-A and I-B).

This oxidative decomposition of ascorbic acid to dehydro-ascorbic acid and the transfomration of the latter to 2, 3-diketogulonic

TABLE—1

Physico-Chemical Properties of Pouch Materials

Property		PET/PE	MET. PET/PE	MP/HD -LD + PET/HD—LD	PET/FOIL/PE
Tensile strength	MD	2.7	2.90	4.42	3.54
(KN/m)	TD	2.8	3.09	4.56	3.16
Heat seal strength (%)		72.8	57.2	6.00	31.90
W.V.T.R. g/m² day at 38°C and 90% RH grad.		3.6	0.6	0.60	Nil
Oxygen transmission rate, cc/m² day atmosphere, at 27°C		75.0	4 0	2.00	Nil

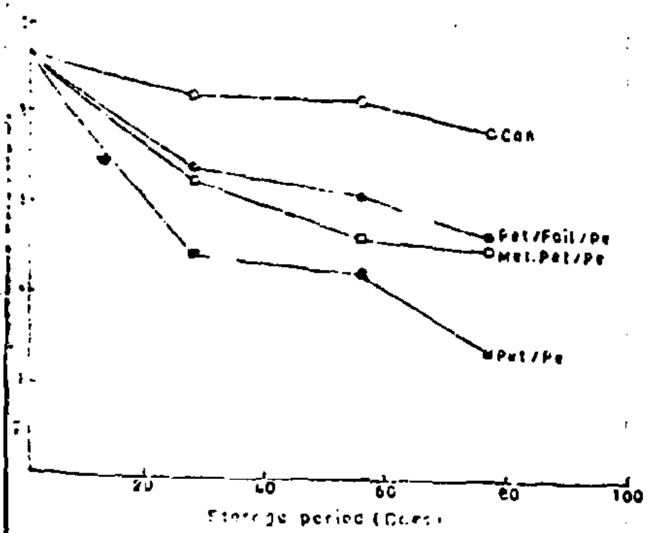
MD : Machine Direction

TD : Transverse Direction

TABLE—2

Changes during storage at room temperature and 37°C

Packaging material used	Storage period (weeks)	Brix (°B)		Acidity as anhydrous citric acid (%)		Reducing sugars (g/100 g)		Total reducing sugars (g/100 g)	
	INITIAL	23.0		0.35		8.8		20.8	
		R.T.	37°C	R.T.	37°C	R.T.	37°C	R.T.	37°C
PLAIN PET/PE	4	22.4	22.4	0.326	0.333	8 79	9.29	21.7	21.7
	8	23.0	23.0	0.326	0.333	8.58	8.84	21.5	21.5
	11	23 0	23.0	0.330	0.330	8.13	9 03	21.6	21,8
MET. PET/PE	4	22.4	22.4	0.326	0.333	8.10	8 83	21.8	21.9
	8	23.0	23.0	0.326	0.333	8.92	9.58	20.6	20.2
	11	23.0	23.0	0 330	0.330	8.46	10.16	21.8	21.8
PET/FOIL/PE	4	22.4	22.4	0.326	0.333	8.50	9.79	21.7	22.1
	8	23 0	23.0	0.330	0.330	9.10	10.00	21.4	22.1
	11	23.0	23.0	0.330	0.330	9 29	10.29	21.8	22.1
CAN	4	23.2	23.4	0.352	0.352	11.00	12 50	22.1	22.8
	8	23.0	23.0	0.349	0.350	11.48	12.93	22.1	22 7
	11	23.0	23.0	0.350	0.350	11.22	12.50	22.0	22 9



I A. Abcorbic acid retention at room temperature

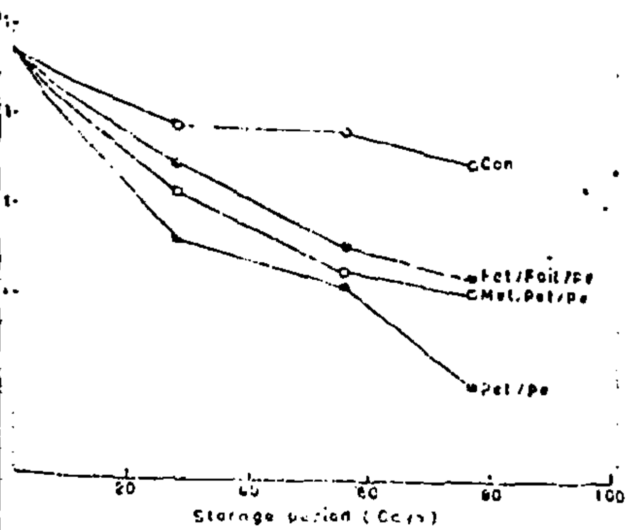


Fig. I B. Ascorbic acid retention at :7°C

...cid is the effect of oxygen that has been ...ready present (cans) or its entry from the ...tside atmosphere into the flexible pouches. ... this aspect cans fared very well at all ...fferent storage temperatures being the best ...rrier packaging system against atmospheric ...ygen[13].

β-Carotene :

From the results, it is clear that the loss of β-Carotene in cans during the storage period of 77 days was 31% at RT and 35% at 37°C. In the case of flexible packaging materials the loss of β-Carotene was less in PET/foil/PE i.e. 65% at RT and 72% at 37°C., as compared to MET/PE i.e. 79% at RT and 82% at 37°C at the same storage period. In the case of Met. PET/HD-LD+PET/HD-LD, the loss of β-Carotene was found to be 80% at RT and 84% at 37°C and in the case of PET/PE, it was found to be 82% at RT and 86% at 37°C. (Figs. II-A and II-B).

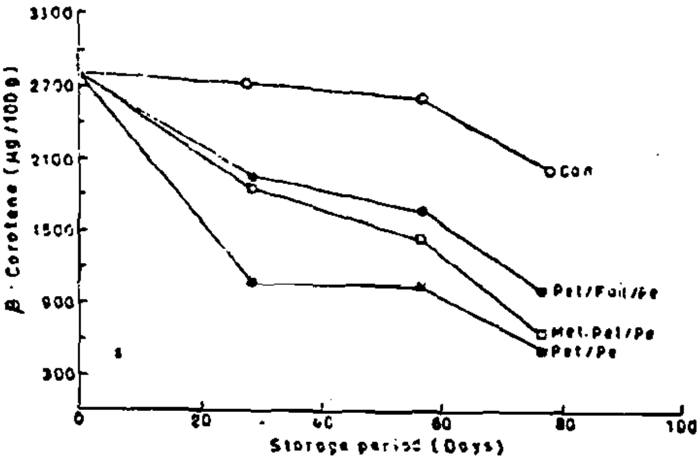


Fig. II A -Carotene retention at room temperature

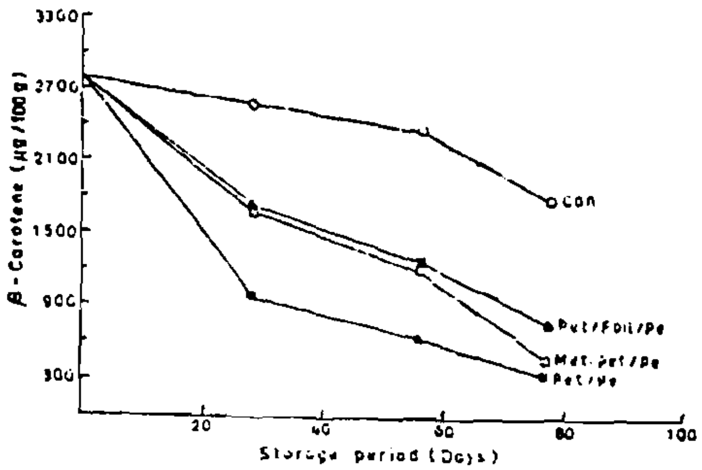


Fig. II B ·C otene retention at 37°C

The main cause of Carotenoid degradation is oxidation. If oxygen is present, extensive losses of carotenoids occur, stimulated by light, enzymes and co-oxidation with lipid hydroperoxides, chemical oxidation of β-carotene appears to yield primarily the 5-6 epoxide, which may later isomerise to mutachrome, that is 5-8 epoxide. Light catalysed oxidation yields primarily mutachrome[11].

In the absence of oxygen, there are number of possible thermal transformation, particularly Cis-trans isomerisation to the neo-β-carotenes. Overall losses of vitamin A activity during anaerobic sterilization may vary from 5 to 50% depending on temperature, time and the nature of carotenoids. At higher temperature, β-carotene can fragment to yield a series of aromatic hydrocarbons, the most prominent is ionene[7].

Non-enzymatic browning :

The cause of discolouration in the mango juice in this investigation work is due to non-enzvmatic browning caused by Mailard reaction and ascorbic acid browning. The mailard reaction is the condensation of reducing sugars with amino acids, peptides and proteins giving rise to hydroxy methyl furfural. The HMF formation during storage was measured and tabulated in Table 3. From the results obtained it was found that the Mailard reaction accelerates at higher temperature and also in presence of oxygen In flexible packaging materials due to permeability the presence of oxygen will bemore which accelerates the above reaction thereby increasing browning also.

Organoleptic evaluation :

Overall acceptability :—At room temperature, the can was judged as excellent after the storage period of 77 days. The critical level (Just acceptable) was attained in the case of PET/foil/PE laminate in 74 days and after that the product was not acceptable. In the case of MP/PE the product attained the critical level in 47 days and PET/PE in 30 days.

At 37°C, the can was judged as very good after the storage period of 75 days The critical (just acceptable) was attained in the case of PET/foil/PE laminate in 53 days and in the case of MP/PE in 39 days. In the case of PET/PE the critical level was attained in 19 days.

From the statistical analysis (Tables 4 and 5) of the sensory evaluation data it was found that at RT and 37°C can is significantly superior and the plain polyester is

TABLE—3

HMF formation during storage after 77 days

Temperature of storage	HMF as mg %			
	Can	PET/FOIL/PE	MET. PET/PE	PET/PE
Room temperature	0.916	3.08	3.58	5.50
37°C	2.100	6.55	6.25	7.89

TABLE—4

Average organoleptic scores of mango juice at room temperature

Packaging material	Storage period (weeks)	Colour	Odour	Taste	Overall acceptability
	INITIAL	5.0	5.0	5.0	5.0
PET/PE	4	4.0	3.0	2.3	3.1
	8	2.3	1.8	1.6	1.9
	11	1.3	1.3	1.3	1.3
MET. PET/PE	4	4.0	3.6	3.4	3.7
	8	3.2	2.3	2.5	2.7
	11	2.3	2.3	2.3	2.3
PET/FOIL/PE	4	4.4	3.8	3.9	4.0
	8	3.6	3.3	3.3	3.4
	11	3.2	3.0	2.9	3.0
CAN	4	5.0	5.0	5.0	5.0
	8	5.0	5.0	5.0	5.0
	11	5.0	5.0	5.0	5.0

TABLE—5

Average organoleptic scores of mango juice at 37°C

Packaging material	Storage period (weeks)	Colour	Odour	Taste	Overall acceptability
	INITIAL	5.0	5.0	5.0	5.0
PET/PE	4	3.3	2.1	2.2	2.5
	8	2.3	1.8	1.6	1.9
	11	1.0	1.0	1.0	1.0
MET. PET/PE	4	3.4	3.2	3.3	3.3
	8	2.7	2.2	2.6	2.5
	11	2.0	2.0	2.5	2.2
PET/FOIL/PE	4	4.3	3.5	3.8	3.9
	8	3.0	2.8	2.8	2.9
	11	2.8	2.6	2.6	2.7
CAN	4	5.0	4.7	4.6	4.8
	8	4.9	4.5	4.5	4.6
	11	48	4.4	4.4	4.5

TABLE—6
Microbiological Test at room temperature and 37°C

Packaging material	Storage period (weeks)	Room Temperature: Total bacterial count	Total mould count	Qualitative coliform test	37°C: Total bacterial count	Total mould count	Qualitative coliform test
PET/PE	4	Nil	10	—ve	Nil	Nil	—ve
	11	Nil	Nil	—ve	Nil	Nil	—ve
MET. PET/PE	4	Nil	Nil	—ve	Nil	Nil	—ve
	11	Nil	Nil	—ve	Nil	Nil	—ve
PET/FOIL/PE	4	Nil	Nil	—ve	Nil	Nil	—ve
	11	Nil	20	—ve	Nil	Nil	—ve
CAN	4	Nil	Nil	—ve	Nil	Nil	—ve
	11	Nil	Nil	—ve	Nil	Nil	—ve

significantly inferior after the storage period of 11 weeks. PET/foil/PE is comparable with can upto 10 weeks at ambient temp. and 8 weeks at 37°C. Met. PET/PE and Met Pet/HD-LD+PET/HD-LD are not significantly different.

Microbiological Evaluation :

The microbiological test results of samples of mango juice packed in cans and flexible pouches at RT and 37°C. for variable periods show that there was no microbiological spoilage in the product (Table 6).

However, the total mould count in the case of PET/PE after 4 weeks and PET/Foil/PE after 11 weeks at room temperature showed positive results with low count. This may be due to the presence of pinholes or sealing defects of the pouch.

SUMMARY AND CONCLUSION

There was no significant change in total soluble solids and acidity in all the packaging systems at the two different storage temperatures for variable storage periods. Based on the organoleptic quality of the product, it may be concluded that PET/Foil/PE is suitable for packing mango juice upto 10 weeks storage at ambient temp. and 8 weeks at 37°C. Met. PET/HD-LDPE+PET/HD-LDPE was suitable only upto 7 weeks at ambient temp. and 5 weeks at 37°C. Product packed in PET/PE pouches was having poor shelf-life as compared to other packaging materials.

Microbiological results show that the product is safe and on the whole the product can be considered as commercially sterile.

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Before you attempt consider what you can perform.

—*Francis Bacon*