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Microbial and sensory evaluation of ohmic heat processed mango juice

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Development of new technologies in thermal food treatments are showing promise for industrial and scientific processing of foods with minimum nutrient loss. Fruits and their products have gained considerable importance by contributing significantly to the economy of India, the second largest producer of fruits and vegetables in the world. Food quality preservation through ohmic heating processing (OHP) technology is useful for the treatment of protein rich perishable foods like fruits which tends to denature and coagulate when thermally processed. Microbial inactivation in relation to ohmic heating is primarily thermal in nature, much like conventional heating. At low frequencies (50-60 Hz) and high field strengths, charges were built upon the porous cell walls of the micro-organism. The thermal pasteurization and OHP exhibited in the present study significant reduction in microbial load and prolonged shelf-life of mango juice. The study results obtained support the use of OHP to improve the quality of mango juice along with safety standards as an alternative to thermal pasteurization.

Key Words : Ohmic heat process, Mango juice, Microbial, Sensory

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INTRODUCTION

Ohmic heating is one of the newest alternative processing techniques to emerge in the last 15 years. The mango puree can be the co-product of the fresh fruit or canned slice packing operations. In addition, some cultivars and mango seedlings are extremely fibrous but very flavourful. The fibre content precludes their use for fresh market, so juicing is the logical alternative. As long as this texture defect is not accompanied by the characteristic terpene-like flavour of many chance seedlings, the fruit has beverage value. The extracted puree is susceptible to browning and should be processed immediately. The pH will generally range from 4.5 to greater than 5.0. Thus, acidification with citric acid to pH 4.0 is necessary, if the puree is to be pasteurized. A hot fill temperature of approximately 95ºC for 2 min is adequate for sanitary puree or nectar, followed by rapid cooling. Canned or glass packed products should be heated and cooled carefully to prevent scorched flavor and browning. Nagy *et al.* (1993) recommended for optimum flavour and colour, rapid blanching at approximately 90ºC for 1 min followed by cooling to about 30ºC followed by freeze preservation. Microbial

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inactivation in relation to ohmic heating is primarily thermal in nature, much like conventional heating. At low frequencies (50-60 Hz) and high field strengths, charges were built upon the porous cell walls of the micro-organism (Cho *et al.,* 1996). This electroporation occurs because the cell membrane has a specific dielectric strength, which can be exceeded by the electric field. The pores formed can vary in size depending on the strength of the electric field and can reseal after a short period of time. Excessive exposure to the electric fields can cause the cell death due to the leakage of intracellular components through the pores.

The aim of this work is to characterize before and after ohmic heat treatments, comparing the effects in terms of sensorial properties and also to confirm the inactivation effect of the electric current in ohmic heating on micro-organisms in fruit pulp.

METHODOLOGY

The mango samples were purchased from Koyembedu vegetable market, Chennai. Fruit juice were extracted using a motorised juice extractor. The juices were strained to maintain the uniformity in sample and minimising individual sample error the prepared sample were adjusted for a uniform standard (codex-FAO) initial Brix value of 13.0 and pH 3.5 should be maintained with sterile distilled water and citric acid as per FAO recommendations.

Microbial analysis:

The total plate count defining (aerobic, mesophilic organisms) micro-organism colonies that grow in 72 hours on an agar plate normed for microbiological testing at a controlled temperature of37°C was done as per the standard method and interpretation was done (Handbook of Foods / ISO 4833:2003). One mL of the fruit samples (Thermal and OHP treated) were diluted 1:10 using 0.1 per cent peptone water. From each of these dilutions, two samples were plated and incubated at 37°C for72 h, and numbers of colonies were counted. One-millilitre of each samples for microbiological analysis was taken at specified sampling intervals and was immediately cooled in an ice-water bath. Viable counts were determined by the standard plate method using plate count agar (Merck, Germany). After all plates were incubated at 37°C for 72h and colonies were counted. The plates were enumerated visually and reported as log cfu/ml.

Sensory evaluation:

Conventional heat treatment and OHP subjected fruit samples in three different packages were kept in refrigeration (4^0C) storage for 60 days. Sensory evaluation was done based on 9.0 hedonic scale to evaluate sensory attributes. Where, score 1 is for ‘dislike extremely’ and 9 for ‘like extremely’ by a panel of judges (Amerine *et al*.,1965) during storage period. Panellist was asked to identify the quality of sample in the given proforma. Each set of sample was repeated three times and analysed statistically.

OBSERVATIONS AND ASSESSMENT

Total plate count for thermally and OH processed treated at three different voltage gradient of 30V/cm, 40V/cm and 50V/cm of pulp samples stored at 5°C for the storage period of 60 days at 15 days intervals is shown in Table 1, 2 and 3. It was found that between treatment the processed samples were highly non-significant (P<0.01) in all the treatments when compared to the thermal treatment after 60 days of storage. During the analysed interval of 0, 15, 30, 45 and 60 days of storage period the least variation was obtained all the packaging material. It was found that the processed samples were highly significant (P<0.01) in all the packaging materials. It was also found that total plate count were within the

Table 1: Total plate count in OHP treated mango juice samples stored at 5°C for polyethylene sachets

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	0.5± 0.22 ^{aA}	0.5± 0.22 ^{aA}	0.33± 0.21 ^{aA}	0.33± 0.21 ^{Aa}	0.19 ^{NS}
15	0.50± 0.21 ^{aA}	0.66± 0.21 ^{aA}	0.33± 0.21 ^{aA}	0.50 ± 0.22 ^{aA}	0.39 ^{NS}
30	6.00 ± 0.36 ^{bB}	4.83.± 0.47 ^{aB}	3.83 ± 0.47 ^{aB}	4.33± 0.42 ^{aB}	4.49*
45	7.66 ± 0.42 ^{aC}	9.66 ± 0.49 ^{bC}	7.33± 0.56 ^{aC}	7.83 ± 0.30 ^{aC}	5.31**
60	11.6 ±0.60 ^{aD}	10.33± 0.61^{aD}	10.33± 0.61^{aD}	10.33± 0.42 ^{ad}	0.94 ^{NS}
F value	140.18**	117.89**	120.47**	179.97**	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01)

Table 2: Total plate count in OHP treated mango juice samples stored at 5°C for retort pouches

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	0.5± 0.22 ^{aA}	0.33± 0.21 ^{aA}	0.52± 0.22 ^{aA}	0.51± 0.22 ^{aA}	0.14 ^{NS}
15	0.33± 0.22 ^{aA}	0.33± 0.22 ^{aA}	0.33± 0.22 ^{aA}	0.33± 0.22 ^{aA}	0.00 ^{NS}
30	4.83 ± 0.40 ^{aB}	4.00 ± 0.36 ^{aB}	3.00 ± 0.36 ^{bB}	4.33± 0.42 ^{bB}	3.96*
45	4.16 ± 0.60 ^{aB}	4.33 ± 0.49 ^{aC}	4.00± 0.47 ^{aB}	4.33 ± 0.42 ^{aB}	0.10 ^{NS}
60	7.50± 0.42 ^{aC}	7.83± 0.30 ^{bD}	7.33± 0.56 ^{aC}	6.16 ± 0.70 ^{aC}	1.94 ^{NS}
F value	58.19**	88.41**	58.05**	35.54**	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01)

Table 3: Total plate count in OHP treated mango juice samples stored at 5°C for glass bottles

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	0.5± 0.22 ^{aA}	0.5± 0.22 ^{aA}	0.33± 0.21 ^{aA}	0.33± 0.2 ^{aA}	0.19 ^{NS}
15	0.33± 0.21 ^{aA}	0.33± 0.21^{Aa}	0.33± 0.21 ^{aA}	0.33± 0.21 ^{aA}	0.00 ^{NS}
30	3.83 ± 0.47 ^{aB}	3.33.± 0.49 ^{aB}	3.00± 0.36 ^{aB}	4.33± 0.42 ^{aB}	1.73 ^{NS}
45	4.16 ± 0.60 ^{aB}	4.16 ± 0.54 ^{aC}	3.83± 0.41 ^{aB}	3.83 ± 0.40 ^{aB}	0.15 ^{NS}
60	6.83± 0.54 ^{aC}	6.66± 0.71 ^{aD}	6.16± 0.70 ^{aC}	7.83 ± 0.30 ^{aC}	1.41 ^{NS}
F value	38.38**	30.88**	35.01**	95.54**	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01)

Table 4 : Sensory analysis of the OHP treated mango juice samples stored at 5°C for polyethylene sachets

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	7.24± 0.02 ^{aA}	7.30± 0.05^{aA}	7.35± 0.07 ^{aA}	7.28± 0.05 ^{aA}	0.680 ^{NS}
15	7.05 ± 0.05 ^{aA}	7.14 ± 0.06 ^{aA}	7.18 ± 0.09 ^{aA}	7.09 ± 0.05 ^{aA}	0.658 ^{NS}
30	7.22 ± 0.15 ^{aA}	7.16 ± 0.05 ^{aA}	7.18 ± 0.06 ^{aA}	7.09 ± 0.59 ^{aA}	0.330 ^{NS}
45	7.81 ± 0.09 ^{aB}	7.75 ± 0.09 ^{aB}	7.62± 0.11 ^{aB}	7.59 ± 0.14 ^{aB}	0.880 ^{NS}
60	7.11± 0.05 ^{aA}	7.14± 0.06 ^{aA}	7.12± 0.06 ^{aA}	7.18 ± 0.09 ^{aA}	0.180 ^{NS}
F value	11.26**	14.15**	5.94**	5.42**	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01)

Table 5: Sensory analysis of the OHP treated mango juice samples stored at 5°C for retort pouches

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	7.42± 0.03 ^{aA}	7.38± 0.05 ^{aA}	7.42± 0.05 ^{aA}	7.42± 0.05 ^{aA}	0.098^{NS}
15	7.60 ± 0.13 ^{aA}	7.55 ± 0.20 ^{aA}	7.51 ± 0.18 ^{aA}	7.85 ± 0.28 ^{aA}	0.513 ^{NS}
30	8.34 ± 0.11 ^{aC}	8.25 ± 0.09 ^{aB}	8.22 ± 0.10 ^{aB}	8.31 ± 0.10 ^{aB}	0.263 ^{NS}
45	8.88 ± 0.14 ^{aD}	8.73 ± 0.10 ^{aC}	8.70± 0.09 ^{aC}	8.79 ± 0.09 ^{aB}	0.238 ^{NS}
60	8.00± 0.22 ^{aB}	8.02± 0.23 ^{aB}	8.01± 0.19 ^{aB}	8.17 ± 0.17 ^{aB}	0.150 ^{NS}
F value	12.13**	12.31**	14.76**	9.66**	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01)

Table 6: Sensory analysis of the OHP treated mango juice samples stored at 5°C for glass bottles

Days	Thermal	30V/cm	40V/cm	50V/cm	F value
0	8.5± 0.18 ^{aA}	8.6± 0.11 ^{aA}	8.59± 0.15 ^{aA}	8.63± 0.17 ^{aA}	0.178 ^{NS}
15	8.73 ± 0.08 ^{aA}	8.68 ± 0.16 ^{aA}	8.35 ± 0.17 ^{aA}	8.68 ± 0.16 ^{aA}	1.390 ^{NS}
30	8.92 ± 0.05 ^{aB}	8.94 ± 0.03 ^{aA}	8.95 ± 0.08 ^{aB}	8.97 ± 0.01 ^{aA}	0.171 ^{NS}
45	8.99 ± 0.00 ^{aB}	8.90 ± 0.07 ^{aA}	8.96± 0.08 ^{aB}	9.05 ± 0.02 ^{aB}	1.060 ^{NS}
60	8.64± 0.15 ^{aA}	8.53± 0.18 ^{aA}	8.53± 0.18 ^{aA}	8.62 ± 0.15 ^{aA}	0.120 ^{NS}
F value	3.11**	1.87^{NS}	3.60**	2.54^{NS}	

Means bearing similar subscript do not differ significantly NS= Non-significant (P>0.05) ** Highly significant (P<0.01) standard range in the OH processed papaya samples packed in the glass bottle and retort pouch packaging materials during the storage period for 60 days. It was also found that there was no significant difference (P>0.05) in the overall acceptability values between the treatment. Overall acceptability values in 9 point hedonic scale for thermally and OH processed treated at three different voltage gradient of 30V/cm, 40V/cm and 50V/cm of papaya pulp samples stored at 5°C for the storage period of 60 days are shown in Table 4, 5 and 6.

The present work aimed to study the use of Ohmic heating at different voltage treatments in the processing of mango juice packaged in three different package materials compared to conventional method. (Pala and and Toklucu, 2011 and 2013) (Bull *et al*., 2004). The main shelf-life quality attributes of mango juice studied referred to the colour changes, microbial load and sensory evaluation. Earlier reports on sensory stability of whole mango juice reference to influence of temperature and storage time by Oliveira *et al*. (2012) reported that the sensory changes observed by the trained panel were related to the degradation of vitamin C and changes in the colour co-ordinates (L* and ΔE*) of mango juice and the consumers were unable to detect changes in the overall quality of the juices. The present study observed a characteristic significant difference in processed mango juice samples stored at 5^oC for 60 days. The present research finding with reference to mango juice OH process show no significant difference with package materials and storage upto 60 days at 5^oC.

The changes in sensory characteristics are affected by various types of reactions, such as enzymatic, chemical, and microbiological reactions, whose degradation rate are highly influenced by factors such as storage temperature and time. Throughout the study, the samples showed good microbiological stability at the three package materials used and in the storage condition studied complying with the FAO standards of cfu/mlmaintained below 10 which could be attributed to the destruction of pathogens during ohmic heating treatment at the low frequency (50-60 Hz) which allows the cell walls of the micro-organisms to build up charges and form pores causing lethality to spores by electroporation (Parrot, 1992 and Nadzirah *et al*., 2013) which is characteristics of MEF (Moderate Electric Field) processing; wherein the effect of the field, with or without the resulting heat, is used for processing. Thus the thermal pasteurization and OHP exhibited significant reduction in microbial load and prolonged shelf-life of mango juice. The study results obtained support the use of OHP to improve the quality of mango juice along with safety standards as an alternative to thermal pasteurization.

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