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Studies on effect of enzymatic liquefaction on quality characteristics of Kesar mango pulp

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Abstract

The effect of pectinase at various concentrations of 0.5, 1.0, and 1.5% respectively and combination of pectinase (0.5%) + gelatin (0.5%) on enzymatic liquefaction of mango pulp, its physico-chemical characteristics and sensory qualities was investigated. It was observed that the pectinase and gelatin each at 0.5% concentration significantly improved the yield, Total Soluble Solids (TSS) and ascorbic acid content of the pulp. The juice was found clarified with TSS of 20% over unclarified with 18%. The sensory quality was improved significantly both by pectinase alone and also with combination of pectinase with gelatin.

Introduction

Recently, a large variety of new products, based on clarified fruit juice are available in the market. Transparency and homogeneity are two essential characteristics for such products, which can be achieved only by completely removing all suspended solids (SS). Some of these products are sparkling clear beverages like (soft drinks, clear juice cocktails, natural aromatic waters, mineralised water, alcoholic beverages, cold teas with clear juice), candies (melting products), pastries (natural essences, translucent fruit sauce), uniformly pulpy fruit juice blends (cocktails, ice-creams, sorbets, etc.), natural translucent jelly products (fruit jellies, gelatines, etc.), fruit honey or fruit sugar, 100% canned fruit (with clear juice as syrup) and cosmetic products. This list shows that several market opportunities exist, not only for the traditional clear apple juice, but also for clarified juices made from fruits or vegetables with originally high pulp content. In addition to this market demand also exists for high-quality fruit juices (Vaillant *et al*., 2001).

Mango (*Mangifera indica* L.) is the most important fruit crop in tropical and sub-tropical regions of the world. Mango fruit is considered to be one of the best fruits in the world market because of its excellent flavour, attractive fragrance, beautiful colour, delicious taste and nutraceutical properties (Salunkhe and Desai, 1984). Mango pulp is macerated mass of fleshy and edible portion of the fruit. The higher per cent yield of pulp justifies its processing quality. Mango pulp is mainly used for juice-based value added products such as natural juice, nectar, jam, jelly, powder, fruit bar and flakes. The sensory quality of products is associated with excellent mango flavour and taste of pulp. The non-homogenous and viscous nature of pulp is sometimes undesirable to prove its feasibility as a base for speciality products. The quality of such products can be improved by treating mango pulp with liquefying enzymes reducing the viscosity and increasing the per cent juice yield (Sreenath *et al*., 1995). The paucity of literature on enzyme induced liquefaction remained deprived of standardized optimum conditions for various protocols. The progressive pectinase enzyme maceration leading to liquefaction of mango pulp helped in improving the quality features of clarified juice. The enzymatic liquefaction of pulp as a function of enzyme concentration, incubation time and hydrolysing temperature is standardized to obtain a desired yield of brilliantly cleared juice (Bhattacharya and Rastogi, 1998). Therefore, in the present investigation the attempts were made to standardize process for clarifying the mango pulp in to clear juice by using enzyme and gelatin which would be used as base for development of sparkling clear beverages.

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Materials and Methods

Extraction of mango Pulp

The complete and uniformly ripened Kesar mango (*Mangifera indica* L.) fruits free from blemishes and visible symptoms of spoilage were obtained from local fruit market of Aurangabad city. They were washed, cleaned, peeled thoroughly and destoned technologically to preserve bulky edible mass. The pulp was homogenized in laboratory fruit processor and was further heated to 72^0C for 15 s to inactivate in vivo enzymes in the pulp followed by cooling. The Potassium metabisulphite (KMS), a chemical preservative was added at the concentration of 1000 ppm and stored at refrigerated temperature (4 ± 1^0C) for further use (Balmeet *et al*., 2004).

Enzymatic treatment

The commercial grade enzyme (fungal pectinase) and gelatin were added in predetermined concentrations in mango pulp and kept in a water bath at around 45^0C. The pulp samples were then removed after every 60, 120 and 180 min of incubation periods respectively. The treated pulp was heated to 80^0C for 30 s to inactivate the enzymes. The liquefied pulp resulted in feasible for releasing free flowing clarified juice. The clarified juice then vacuum filtered, filled in glass bottles for further use.

The extracted pulp was again treated with enzyme polygalactoronase (PG) and gelatin as a combination treatment at various concentrations viz. T0 (Control), T1 (0.25% PG), T2 (0.50% PG), T3 (0.75% PG), T4 (1.0% PG), T5 (0.5% Gelatin), T6 (1.0% Gelatin) and T7 (0.5% PG and 0.5% Gelatin) respectively. Each treatment was incubated at 60,120 and 180 min respectively. The clarified juice was then stored in 500 ml capacity glass bottles until further use.

Physico-chemical analysis of fresh and clarified mango juice

Total soluble solids (TSS) were determined with the help of digital refractometer (Atago make, Japan), whereas sugars, ascorbic acid and titrable acidity were determined as per standard procedures of (Ranganna, 1986). Titrable acidity was calculated in terms of anhydrous citric acid.

Turbidity measurement

Turbidity as an index for extent of clarification was determined by using portable turbidity meter and results were expressed as Nephlometric Turbidity Units (NTU).

Organoleptic evaluation

The clarified mango juices were evaluated organoleptically with the help of a panel of 50 semi-trained judges on a 9-point Hedonic scale (Ranganna, 1986).

Statistical analyses

The data generated during triplicate experimentation were recorded and statistically analyzed on standard software using standard procedure for analysis of completely randomized design (CRD). The treatment means, their standard errors (SE) and critical differences (CD) at 5% level of significance were worked out for comparison of treatments (Das and Giri, 1988). Further confidence intervals were also worked out.

Results and Discussion

Liquefaction of mango pulp

The Kesar mango pulp extracted was subjected to various enzymatic and chemical fining agents for its liquefaction or partial clarification in order to justify its suitability for the production of processed products. The effect of enzyme concentrations and chemical fining agent (gelatin) on the mango pulp with respect to nutritional retention and sensory qualities was also investigated. The results obtained are presented and discussed under suitable headings and sub-headings.

Proximate composition of mango

It was observed that Kesar mango (Table 1) recorded higher moisture content (82.03%), TSS (17.5^0Brix), acidity (0.31%), considerable amount of vitamin C (21.34 mg/100 g), ß-Carotene (1869 µg/100 g), and comparable amount of mineral content. The proximate composition of mango reported to be in proximity with the findings of the earlier researchers (Gopalan *et al*. 1996; Sakhale *et al*., 2012).

Physico-chemical characteristics of treated mango pulp

The data presented in Table 2 indicated that a percent yield of mango pulp was 38% when the pulp was extracted without any enzyme or fining agent. When a pulp was extracted after enzymatic liquefaction by either use of pectinase at various concentrations or by pectinase and gelatin in equal proportion, there was drastic increase in the juice yield at all the incubation periods. The increase in yield of juice was significant in all the cases. It was highest (72.3%) when pulp was liquefied with pectinase and gelatin for incubation time of 180

Table 1. Proximate composition of ripe mango fruits

Parameters	Values
Moisture (%)	82.05
Total Soluble Solids (^{0}Brix)	17.50
Acidity (%)	0.31
Ascorbic acid (mg/100gm)	21.34
Reducing sugars (%)	04.35
Total sugars (%)	11.22
ß-Carotene content (µg/100g)	1869
Iron (mg/100gm)	1.32
Calcium (mg/100gm)	14.40
Density (g/ml)	01.04

*Each value is an average of three determinations

min followed by incubation time of 120 min and 60 min when pectinase enzyme was alone used at a concentration of 1.0%. The juice yield was also increased significantly at all the incubation period over rest of the enzyme concentrations at all the incubation times. However, the TSS content was increased significantly on liquefaction of pulp with either 1.0% pectinase or pectinase and gelatin both at incubation time of 180 min.

The marginal increase in rest of the treatments was found non-significant at all the enzyme concentrations. The ascorbic acid content was found increased from 19.82% in untreated pulp to 48.12% in enzyme along with gelatin treated pulp at incubation time of 180 min and the incubation period had a marked influence on the ascorbic acid content in all the treatments at all the incubation periods. There was no change observed in titrable acidity of pulp treated by pectinase at all concentrations neither by pectinase or gelatin.

On the basis data on enzyme induced liquefaction process standardized with limiting factors such as enzyme concentration, incubation time, it could be hypothesized that enzyme induced liquefaction processing technology characterized by 1.0% pectinase concentration for 180 min incubation period and 72.3% yield at an ambient temperature has great potential to adopt for commercial application. During liquefaction process, substantial increase in nutrients (ascorbic acid, carbohydrates, and organic acids) confined that incubation period may be associated with progressive maceration of the tissue cells of edible mass of fruit facilitating easy liberation of its tissue-entrapped content. Similar results have also been reported by (Will *et al*., 2002; Narayana *et al*., 2002; Singh *et al.*, 2006; Liew *et al*., 2007). The enzymatic liquefaction process not only helped in increasing the overall yield of juice but also upgrading the quality features of the extracted juice leading to sparkling clarity.

The data on efficacy of enzymatic liquefaction process for upgrading the quality of juice presented in Table 3 indicated that there was significant increase in TSS, reducing sugars, and titrable acidity in enzyme treated pulp as compared to extracted untreated pulp. It was also interesting to note that significant decrease in ascorbic content in a clarified juice as compared to enzyme liquefied mass of fruit may be associated with the oxidation of ascorbic acid because of exposure to the atmospheric conditions during processing. The progressive maceration process leading to liquefaction is dependent on hydrolytic action of pectic enzymes on polygalactoronic acid chains. The ascorbic acid content retention is one of the quality features for judging the quality of finished juice. In the present study, the decrease in ascorbic acid content of clarified mango juice (8.86 mg/100 g) against (22.23 mg/100 g) of extracted untreated natural pulp. This decrease may be associated with the phases of the processing such as exposure to the atmospheric conditions, effect of fining agents and severity of heat treatment during extraction. The similar results have been reported by Singh *et al.* (2000), Rastogi and Rashmi (1999) and Brasil *et al.* (1995).

Sensory evaluation of clarified mango juice

The clarified mango juice was assessed for its sensory quality parameters to justify its feasibility as a major base constituent for the production of beverages. The sensory quality assessment of clarified mango juice obtained from relative treatments for liquefaction process carried out by a semi trained panel of judges by using 9-point hedonic scale was proved as an asset to justify its feasibility as a secondary raw material for the production of whey based fruit beverages. The data on relative score of quality parameters affected by notified treatments are summarized in table 4.

The relative sensory evaluation score recorded for colour (5.0-5.7) and aroma (5.0-5.6) as quality features reported to be at par irrespective of nature of treatment (T1-T7) even in combination specified by biotic and abiotic fining agents. The higher relative score of taste (5.5-6.8), mouth feel (5.3-6.8) and overall acceptability (5.2-7.2) revealed that progressive maceration of the tissue cell significantly helped in releasing tissue entrapped nutrients regulating overall acceptable quality features.

Table 2. Effect of treatments and incubation time on physico-chemical characteristics of mango pulp*

Treatments	Incubation time (min)	Yield (%w/w)	TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Titratable acidity (%)
T_0	0	38.0	19.00	19.82	0.226
T_1	60	50.0	19.00	19.90	0.224
	120	53.0	19.20	20.40	0.226
	180	60.0	19.25	22.00	0.230
T_2	60	53.0	19.20	20.20	0.225
	120	62.0	19.25	20.80	0.227
	180	64.0	19.52	30.20	0.237
T_3	60	60.0	19.20	22.80	0.238
	120	64.8	19.30	24.20	0.240
	180	66.4	19.60	38.00	0.239
T_4	60	65.0	19.30	25.80	0.239
	120	68.0	19.40	26.00	0.241
	180	70.0	21.20	42.10	0.290
T_5	60	52.0	19.00	21.00	0.228
	120	56.0	19.02	21.00	0.231
	180	58.0	19.02	21.30	0.240
T_6	60	52.0	19.10	21.50	0.230
	120	58.0	19.10	22.00	0.233
	180	59.0	19.10	22.20	0.250
T_7	60	67.0	19.30	26.00	0.240
	120	67.2	19.60	28.00	0.252
	180	72.3	21.00	48.12	0.292

*Each value is average of three determinations.
T_0 (Control), T_1 (0.25% PG), T_2 (0.50% PG), T_3 (0.75% PG), T_4 (1.00% PG), T_5 (0.50% Gelatin), T_6 (1.0% Gelatin), T_7 (Combination)

Table 3. Effect of fining agents on nature of freshly extracted mango pulp

Treatments	TSS (^{0}Brix)	Reducing sugars (%)	Titrable acidity (%)	Ascorbic acid (mg/100g)	Turbidity (NTU)
Conventionally Extracted pulp (Untreated A)	17.00	48.40	0.23	20.23	Turbid
Treated pulp (B)	17.50	52.36	0.25	27.42	Turbid
Physical status of juice					
Cloudy	18.00	51.50	0.29	26.12	15.10
Clear	20.00	56.00	0.30	8.86	02.60
Mean ± SD	17±0.75	48.4±1.35	0.23±0.01		

*Each value is average of four determinations
Treated pulp=0.5% pectinase +0.5% gelatin for 180 min incubation time

Table 4. Sensory quality assessment of clarified mango juice

Treatments	Color	Aroma	Taste	Mouth feel	Overall Acceptability
T_0	5.0	5.0	6.0	6.1	6.0
T_1	5.5	5.3	6.5	6.5	7.0
T_2	5.5	5.2	6.8	6.7	6.8
T_3	5.7	5.4	6.7	6.8	7.2
T_4	5.5	5.6	5.5	5.8	7.1
T_5	5.7	5.5	5.5	5.3	5.2
T_6	5.0	5.0	6.0	6.0	6.0
T_7	5.5	5.4	5.7	6.2	7.0
SE	0.098	0.085	0.185	0.189	0.254
CD (p = 0.05)	0.232	0.202	0.438	0.447	0.602

T0 (Control), T1 (0.25% PG), T2 (0.50% PG), T3 (0.75% PG), T4 (1.00% PG), T5 (0.50% Gelatin), T6 (1.0% Gelatin), T7 (Combination)

The cumulative data on sensory quality features of clarified mango juice strongly supports in standardizing clarification process as characterized by 0.75% concentration of pectinolytic enzyme with 120 min incubation period at ambient conditions. The analogous reports on sensory quality parameters presented by earlier researchers strongly support the above postulation (Sakho *et al.*, 1998; Mantovani *et al*., 2005, Lakshmi *et al*., 2005).

Conclusion

It can be concluded that the mango pulp treated with 0.5% pectin in combination with 0.5% gelatine and incubated at 45^{0}C temperature for the period of 120 min found superior as compared to the rest of the treatments with respect to nutritional and sensory characteristics of clarified mango juice. The clarified juice recorded prolonged stability with nutritional and organoleptic quality. These findings certainly help in defining a quality base for the development of fruit based beverages on a commercial scale.

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