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Comparison of bananas ripened by two methods for textural sale-grades

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Abstract

This study relects on varied maturity levels of available raw and ripe bananas at market level, scope of improvements in quality of bananas by ripening technique and to generate newer avenues for value addition. Raw bananas from the market were ripened in June month both by crude market and standard BIS methods. The final ripeness textural range differed due to ripening methods used {28.56 N (crude market method) and 46.57 N (BIS method) a 63.06 % increase} as compared to available ripe grades in market (same month –June) (13.01 ± 0.99 N) entering after ripening by crude method. Initial texture of available raw grades used as above (June month) was 99.36 ± 10.84 N. The over-ripe bananas (~15 % of bananas available for sale in mandi) if used for beverage yielded an alcoholic drink (with ~8 % alcohol). The processed over-ripe bananas were compared to sale of over-ripe bananas to show potential value addition.

Key words: Banana handling, artificial ripening, texture, Ethephon, banana beverage, texture, and banana grades.

Introduction

India contributes 23.69 % of the world's share of bananas (*Musa* sp.) (UNCTAD, 2000). Transit losses amount to 8.0 – 10 % and 5- 8 % (producer to wholesaler and wholesaler to consumer respectively) in a single wholesale market (mandi) of Bhopal (NHB, 2000). The major problems of festooning banana quality are physical damage, decay and uncrown with unpredictable ripening. Proper maturity at harvest, freedom from defects, care and speed in handling with avoidance of chill injury may reduce the mixed ripe problem in the banana industry (Marchal, 1997; Peacock and Blake, 1970). Ripening characteristics [colour, firmness, and weight of banana (Gutierrez, 1999), vary with country of origin, days in transit, season of the year, maturity when harvested. Pre-mature ripening is probably the biggest cause of loss to the banana trade. There has been difficulty in determining climacteric size of bananas [to reach the market in green condition (Peacock and Blake, 1970)] due to seasonal changes in maturity parameters during growth itself, harvest maturity (as related to bunch age and green life) that varied from one harvest date to another (Montoya *et al.*, 1984). Under these difficulties standard ripening methods that defined banana quality (BIS, 1988) are available but merchants use crude methods. There was thus a need to provide demonstrable results that may be helpful for extension workers to explain the usefulness of standard ripening methods. Our study thus focused on comparing crude method with available standard method for raw bananas ripening.

Materials and methods

Overview and survey of artificial ripening in mandi revealed some traders used calcium- carbide (a banned chemical still used in mandis) (~ 250 g / 100 stacked bunches without ice). We used ethephon at recommended levels @1000ppm (Bureau Indian Standards, 1988) in our experimental set up on artificial ripening. Raw bananas that arrived in wholesale market (Nav Bahar Market, Bhopal) were sampled for 7 different months. Individual banana weights differed if they were in upper or lower portion of the bunch as also noted earlier (Peacock, 1975). Thus due care was taken to get even grade of bunches, collecting them from nearby positions on same main stalk (with bunches having similar curve angle of bananas). Banana samples from bunches were drawn randomly and observed for initial texture and other parameters. Ripe bananas, sampled randomly (as for raw bananas) from 3-4 retailers of the wholesale market (for good representation), were used (sampled in triplicate) for physical texture, colour and physiological parameters {mass, and moisture contents of pulp and peel (% wb)}. Pulp growth increases with the declining growth of peel, especially towards commercial maturity and provides a quantitative estimate of fruit development in relation to postharvest performance (Simmonds, 1966). Thus Pulp: Peel ratio of bananas was observed which gave an estimate of the stage of fruit maturity.

The texture (force of compression of bananas- N at three different positions of the bananas) was measured on a Texture analyzer TA X- 2Ti with a hemispherical plastic probe. The colour (average of three replicates) was observed with a Hunter colour Lab Spectrophotometer with Universal V 3.71 software. The 'CIE-Lab' scale readings were taken using (10/D65 scale) wherein illuminant was D 65 at 10^{o} observer angle. The values were 'L' 0-100 (low to high scale); 'a' more red (+) or more green (-); 'b' more yellow (+) more blue (-). Also a scale of 1 to 8 (von Loesecke, 1949): 1=hard green; 2 = sprung and green; 3 = more green than yellow; 4 = more yellow than green; 5 = green tipped; 6 = fully yellow; 7 = flecking; 8 = browning and over ripe was used to differentiate visibly. Standard deviations on triplicate observations of each month in artificial ripening were represented.

A comparative study of bananas for changes in texture, pulp colour and other physiological parameters, during green to ripe condition, was done (in June month) in banana ripened by two methods: "Crude market" and 'BIS' method (BIS, 1988), simultaneously. Firstly bananas sampled (three replicates) from bunches were observed for physical and physiological changes. Then the BIS method was compared to crude market method of artificial ripening, to demonstrate scope of improving quality (textures, reduced weight loss in ripened condition) of bananas.

For BIS method of ripening, one set (triplicate) of sampled banana bunches were surface dipped in Ethephon (39 % Ethrel solution) @ 1000 ppm of ethylene released from it (*i.e.* ~46 ml/5 l water for 10 min). They were placed in cool chamber (16 –18 °C as per specified by BIS). The other set of raw banana bunches (triplicate) were surface dipped in Ethephon solution (3 lid full =21 ml/10 l water for 10 min) as done in crude market method. They were covered with a gunny bag and over them was placed a slab of ice (~250 g) (in such a way that ice load was not on the bananas directly and only helped to cool as it trickled on melting) and placed in a corner of the room. Fresh ice was placed every 24 h. The approximate temperature under the gunny bag ranged between 19-36 °C. The ripened bananas were observed till 4 d [by 24 h ripening difference observations].

Sampled fresh fruit mass of ripening bananas, moisture contents of peel and pulp were observed during artificial ripening period (Ranganna, 1991).

A survey of the market on the availability of over-ripe bananas was also undertaken. The total over ripe bananas actually present in throwaway condition (sold by 'thela' vendors) was estimated. The monetary losses incurred due to over ripe bananas were estimated to establish the scope of value addition by processing over ripe bananas into banana alcoholic beverage. Over-ripe bananas were processed to an alcoholic beverage (Caputi *et al*, 1965; Pethe, *et al.*, 2003). Alcoholic beverage yield and cost of processing was compared to the losses incurred by sale of over-ripe bananas to show scope of value addition over sale of low quality (over-ripe) bananas if any. Data was analyzed applying one way and two way ANOVA in CRD using MSTATC software

Results and discussion

The banana grades, available in different months in wholesale market of Bhopal (India), differed in maturity (texture, colour and physiological) (Fig. 1, 3a). The compressible texture of raw grades from any month when compared to ripe grades showed higher compressible force texture (Fig. 1) with variations in all months. The raw and ripe grades ranged from 121.18 to 153.19 N (mean 137.81 ± 12.66 N) and 11.46 to 27.44 N (mean 16.18 ± 5.99 N) texture force of compression, respectively. The unevenness in maturity of bananas (Fig. 1, 3a, b, c) as available in market - sale grades was thus a result of uneven harvest maturity (Pp:Pl ratio of raw grades), artificial ripening (of uneven grades used) and also the natural variations due to spiral maturity that already existed in a single stalk of bananas [top to bottom- (Peacock, 1975)]. The raw and ripe grades of bananas varied visibly (von Loesecke, 1949) on 1 to 2 and 7 to 8 scales, respectively. The colour in raw and ripe grades showed variations on L, a, b scales {raw: L 60.54 ±3.64, a -0.35 ±11.42, b 35.98 ±3.86; ripe L 43.87 ±9.47, a 0.75 ±6.24, b 24.82 ±9.83, respectively). Also the moisture contents in pulp in the different months varied between [62.27 ±1.42 to 79.27 ±0.21 nean 73.05 ± 6.32] in raw and [69.22 ±2.51 to 93.51 ± 0.66 mean 78.93 ±7.90] in ripe grades, respectively.

No chill injury was present in the bananas. The cause of variation in pulp colour among different stalks was described primarily to site origin (Hughes and Wainwright, 1994). Results were consistent with earlier reports (Simmonds, 1966) that pulp growth in bananas increased but the growth ratio of peel declined, especially towards commercial maturity (Fig 3 a) and provided a quantitative estimate of fruit development. There were negligible texture and colour (whiteness of pulp) variations (average of triplicate readings) in different sections of a single banana fruit (Fig. 2) of a bunch.

Banana fruit can ripe when pulp: peel ratio reaches 0.5 (Simmonds, 1966). The Pp:Pl ratio range in raw and ripe bananas in market was between 0.54 to 1.97 (mean 1.17 ± 0.46) and 0.82 to 3.08 (mean 2.2 ±0.95), respectively in different months, high ratios for raw banana (Fig. 3a). Also the moisture contents in pulp that contributed to varied texture in raw (62.27 ±1.42 to 79.27 ±0.21 mean 73.05 ±6.32) and ripe (69.22 ±2.51 to 93.51 ±0.66 mean 78.93±7.90) grades, respectively (Fig. 3b). Obviously farmers harvested bananas at different growth stages (in different months) with variations in maturity and hence in ripened grades. The pulp mass content in the raw and ripe bananas available in market varied in different months (Fig. 3b, c) (mean mass: 114.27 ±16.71, 102.02 ±24.82 in raw and ripe grades).

Since for fruit harvested earlier than normal, green life increased by 3-5 d but bunch weight reduced by almost 10 % (Peacock, 1975). Also a relation was established (Montoya *et al.*, 1984) between bunch age and green life, which varied from one harvest date to another. Thus there was need to look into the physiological maturity of bananas harvest according to seasonal variations in temperatures that differed from region to region.

Artificial ripening by the two methods as experimented, showed changes in texture (compressible force on bananas), average mass (g), moisture in pulp (%) and fresh Pp: Pl ratio. Final texture-force of compression (N) of ripened bananas by BIS method was as much as 46.57 ± 0.64 N compared to a texture of 28.56 ± 1.22 N by crude method (Fig. 4).

The bananas ripened by BIS method showed better texture quality.

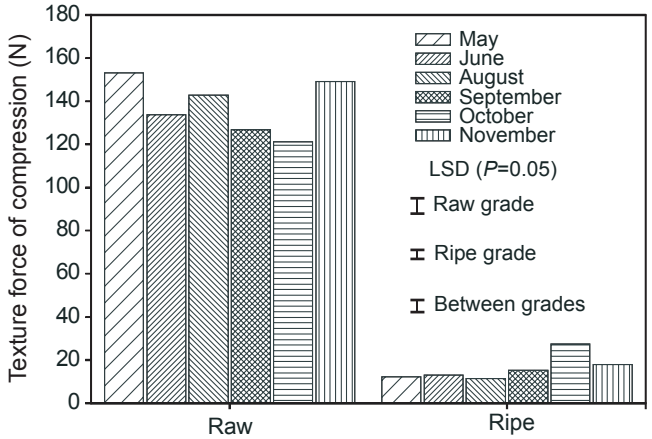

Fig. 1. Variation in texture of bananas (raw and ripe grades) in different months. Vertical bar show LSD (*P*=0.05) for raw and ripe grades.

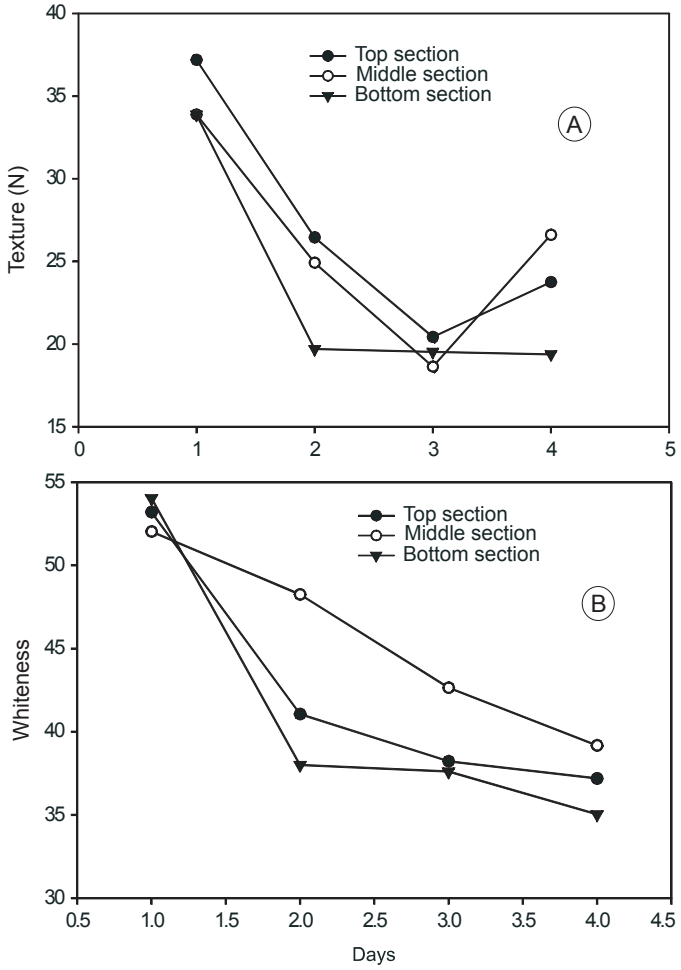

Fig. 2. Texture(A) and colour(B) changes in different sections of ripe banana pulp (on single bunch) during ripening (room conditions).

Colour of pulp, by both methods showed negligible differences. There was enough scope to improve (about 63.06 % higher compressible force) the texture of ripened banana grades by BIS method (rapid procedure). The overall quality of the ripened bananas (BIS method) was better with lesser pulp mass loss in ripening than bananas ripened by crude method (Table 1).

Experimental banana ripening was accomplished at temperature of 16 to 18ºC with high relative humidity 80 % (BIS method to be usually best when ethylene used). A higher Pp: Pl ratio with a good ripeness (17-18 % TSS) was achieved till the last day (4 d) of ripening. Actual usefulness (scope to improve the textural and related physiological quality) of ripened bananas by the BIS standard method has been revealed in this study. This is perhaps an advantage as the consumer prefer a fruit grade that would be better in texture and maturity when retailed.

Thus standard method needs to be perpetuated. There is need to establish studies on suitable stage(s) in raw banana harvesting for green-life and harvest maturity in banana during different seasons. A challenge to orderly marketing was to harvest bananas at proper maturity to get even grades of raw banana fruit (Montoya *et al.*, 1984).

Under the cost considerations BIS method required a cold chamber to be operated at 16 ºC- 18 ºC under maintained 80 % humidity (with say saturated solution of potassium nitrate). If the initial costs (chamber {size according to the need}, chemicals)

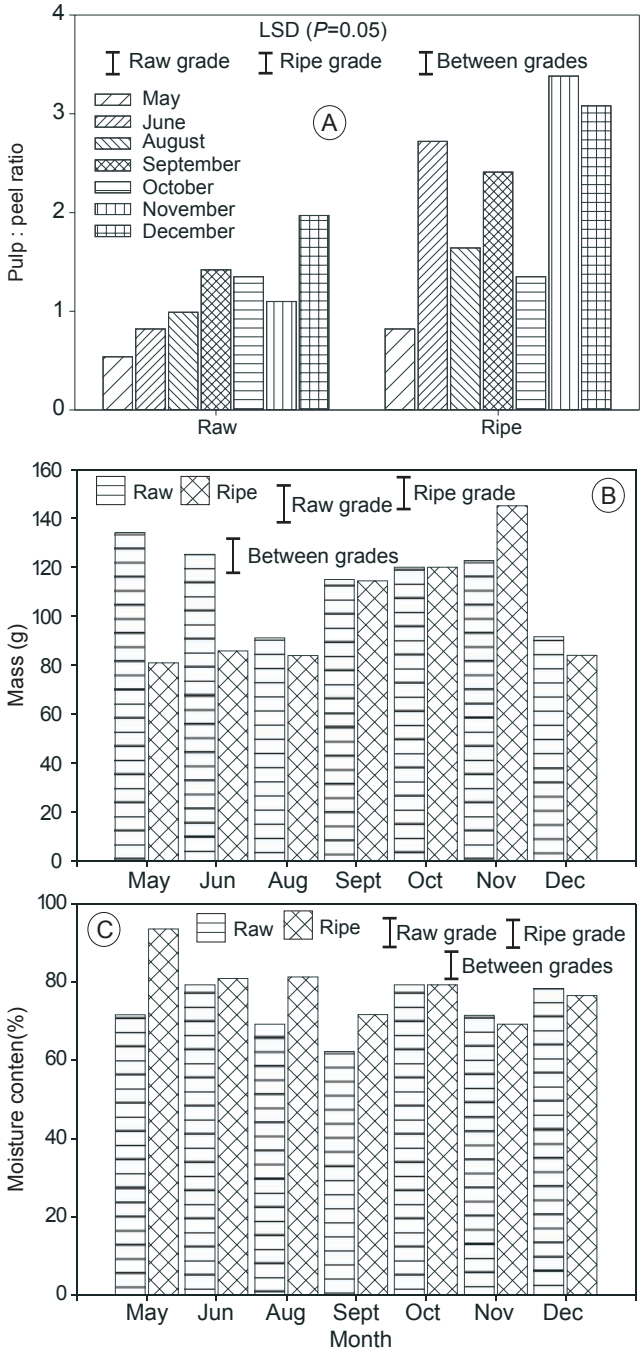

Fig. 3. A) Pulp: peel ratios of bananas grades (raw and ripe) in different months; B) & C) mass and % moisture content (pulp) of bananas (raw and ripe grades) in different months.

was met it could lead to availability of good quality of ripened bananas in market. The unclean conditions caused by ice in crude market method could be avoided.

This may also lead to the reduced use of calcium carbide (banned but still under use), a carcinogen (a major health concern in the market). Centralized ripening systems (CRS) (catalytic generators: web site) available may be checked for their working in the future works under such aspects with features like leak detection, safety, convenience.

Over ripe bananas were abundantly seen in market. Exposing ripe bananas to temperatures (higher than those in the ripening range) after artificial ripening, hastened softening and decay, weakened the neck and peel, and may cause poor colour (Kotecha and Desai,

1995). Thus handling after ripening also needed attention in a tropical country like India. This can be minimized by careful postharvest attention to the fullness of the fruit at harvest, the necessity for speedy loading before the transport.

Table 1**.** Changes in bananas ripening by two different methods in June month

Changes in parameters*	Ripening methods	
	Crude market	BIS
Reduced mass %	13.80 (± 36.08)	5.64 (± 18.63)
Mositure (%) in pulp	3.09 (± 4.67)	3.36 (± 1.31)
Pulp : peel ratio (Fresh)	2.17 (± 0.16	6.76 (± 0.07)

*Changes from initial raw bananas used.

Table 2. Yield of fermented beverage from day's available over-ripe bananas.

Total available over-ripe bananas#	5700
Weight of over-ripe bananas*	460 kg
%Yield of beverage (alcoholic drink)	69.88
Beverage from pulp	321 kg
Over-ripeness in bananas and monetary losses incurred:	
Loss due to over-ripeness	58.3%
Rate of ripe grade	Rs 12/-(max)
Rate of over-ripe grade	Rs 5/- (min)
Loss (difference)	Rs 7 per doz
Monetary loss (due to over ripeness)	7/12 x 100 = 58.3 %

#Estimated value: 15% over ripe bananas, from all retailers in a single day's pick of 19 thelas (selling the different grades of bananas on each thela[$] present) in mandi ([$] four wheeled manual pulling carts/ carriers); *80.66g (mean weight of one banana).

Table 3. Value addition scope by processing of over ripe bananas

Average earning from sale of 5700 bananas 475 doz. @ Rs 5/-)	Rs 3531/-
Beverage cost @ Rs 11/kg (processed from 5700 bananas)(321 kg)	Rs. 2375/-
Value addition by beverage	$\frac{3513-2375}{2375}100 = 48\%$

The over-ripe grades of bananas were processed to alcoholic banana for likeable good quality beverage (Pethe, *et al.*, 2003). Such a banana beverage (with ~8% alcohol) yielded 69.88 % from pulp used. The value addition so obtained (Table 2, 3) showed a scope of ~48% monetarily.

Since the different levels of moisture and pulp: peel ratios were found in bananas and appears to be responsible for bananas maturing differently to over ripe grades. There is need to disseminate standard ripening procedures in the market to be ultimately followed by traders.

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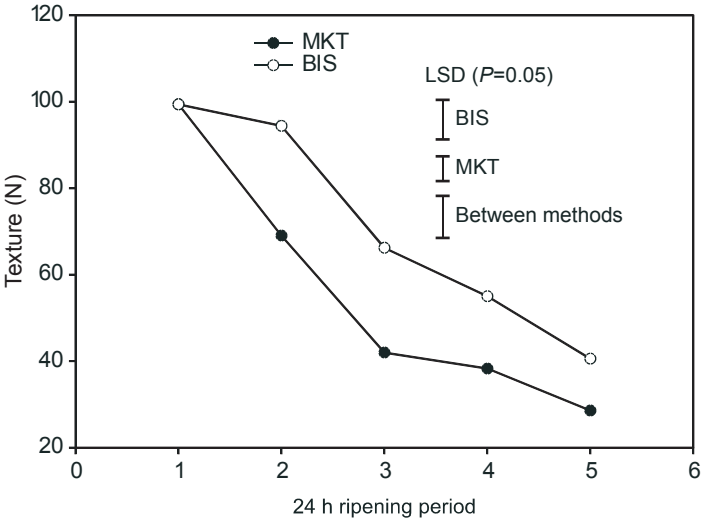

Fig. 4. Lowering of texture during ripening (4 d period) (observed in June) by banana ripening methods (Crude market /BIS).

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