Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 2985-2995

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 2985-2995**
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Maturation on Physico-Chemical Characteristics of 'Gola' Pear (*Pyrus pyrifolia*) Fruit

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A B S T R A C T

This study investigated the effect of stage of maturity on physico-chemical characteristics of Gola pear (*Pyrus pyrifolia*). The fruits harvested from the same farm at 140 & 170 days following full bloom were classified as mature (MG) & ripe (RG) stages, respectively. Randomly selected fruit samples from both stages were analyzed for physico-chemical changes. The physico-chemical properties viz. colour, size, shape, weight, specific gravity, edible portion, moisture, total soluble solid (TSS), titratable acidity, ascorbic acid, pectin,, sugar to acid ratio, crude fiber, pH, total sugar, reducing and non-reducing sugar were analysed by using standard methods. Results revealed that significant changes were observed in size, shape, weight, specific gravity, moisture, ash, pH, TSS, pectin, total sugar and reducing sugar in Gola pear from MG to RG stage. Sphericity, aspect ratio, specific gravity, pH, TSS, total sugar and reducing sugar were 97.49%, 97.66%, 1.04 %, 4.1, 12.33°Brix, 7.01% and 4.02 %, respectively at MG stage and increased significantly after ripening as 101.67 %, 104.44 %, 1.07 %, 4.45, 14.0 °Brix, 9.85 % and 8.67 %, respectively. Whereas, size (5.67%), average weight (101.26g), moisture (86.59%), Ash (0.33%) and pectin content (069%) of Gola pear at MG stage were significantly decreased at RG stage which were 5.25%, 100.8g,84.84%, 0.28% and 0.45 %, respectively. The study recommended that pectin content decreases at ripe stage therefore fruits at mature stage would be good for making jam and jellies, which require pectin essentially for gel formation with sugar.

Keywords

Gola pear, Physico-chemical properties, *Pyrus pyrifolia*, maturity stage, jam, jelly

Introduction

"Fruits and vegetables (F&V) are considered in dietary guidance because of their high concentrations of dietary fiber, vitamins, minerals, especially electrolytes; and more recently phytochemicals, especially antioxidants" (Slavin JL & Lloyd B, 2012). The Expert Committee of the Indian Council of Medical Research, taking into consideration the nutrient requirements, has recommended that every individual should consume at least 100 g fruits daily (National Institute of Nutrition, 2010). Pear (*Pyrus pyrifolia* cv. Gola) belongs to the family Rosaceae. Fruits are large, round, greenish-yellow with prominent dots. Pulp is somewhat gritty, sweet with plenty of juice.

It is a climacteric fruit which ripens from mid to late July. Due to its climacteric nature, it is harvested before ripening to make suitable for long distance transportation.

Pear is one of the temperate zone fruit grown in the hills and subtropical plains of North India. In India, total area occupied by pear was 42.30 hectares with production of 295.09 tonnes in year 2012-13 (National Horticultural Board, 2014).

Pear has maximum production share in Uttarakhand (38 per cent) followed by Jammu & Kashmir (26 per cent), Punjab (21 per cent), Tamil Nadu (10 per cent), Himachal Pradesh (4 per cent) and other states (1 per cent). In Uttarakhand, pear comes on fourth position in production after apple, mango and citrus fruits (India, 2012). Main pear producing districts in the state are Nainital, Pithoragarh, Almora, Chamoli and Uttarkashi.

Fresh pear (Pyrus species) fruit is consumed throughout the world and also commonly found in processed products such as drinks, candy, preserved fruits, and jam (Reiland, H. & Slavin, J.2015). Pear fruit is rich in macronutrients as well as in micronutrients (Senser *et al.,* 1999). It is an excellent source of dietary fibre and also a good source of vitamin C (Silos *et al.,* 2003). Pear fruit also contains health promoting bioactive compounds such as carotenoids (anthocyanins, flavanols, quercetin, kaempferol, isorhamnetin) and plant sterols (Andreotti *et al.,* 2006). The fruit also contains a wide range of phenolic compounds comprising different flavonoid classes (chlorogenic, syringic, ferulic and coumaric acids, arbutin and (-)-epicatechin, hydroxyphenolic acids and the p-hydroquinone-glucoside arbutin) (Schieber *et al.,* 2001; Petkou *et al.,* 2002; Salta *et al.,* 2010).

However, scientific information on the physical and chemical characteristics of pear fruits of 'Gola' variety is scanty. Hence, the aim of this study was to investigate the physico-chemical changes taking place in 'Gola' pear fruit during maturation.

Materials and Methods

Pear fruits (*Pyrus pyrifolia* cv. Gola) were procured from Horticulture Research Centre, Pattharchatta, G. B. Pant University of Agriculture & Technology, Pantnagar. Fruit sample was collected in wooden and plastic bins and brought to the food processing laboratory, Department of Foods & Nutrition. The Fruits were sorted manually to remove infected/damaged fruits, washed under running tap water and blotted dry. The fruits were classified into two stages of maturities (Plate.1 A&B) on the basis of days following full bloom (DFFB) and their skin colour.

Physical Analysis

Fifty fruits of each maturity group were individually analyzed for physical characteristics viz. colour, size, shape, weight, specific gravity and edible portion. Colour for fruit were recorded by visual observations with the help of RHS colour chart (Plate.2).

Average fruit weight was determined by individually weighing fifty pear fruits on electronic balance to an accuracy of 0.001g (Owolarafe *et al.,* 2007). Fruit size was determined by measuring three linear dimensions viz. length, width and thickness using a vernier calliper reading to 0.01mm (Owolarafe *et al.,* 2007).

Fruit shape was expressed in terms of its sphericity index and determined by the method of Mohsenin (1978) as mentioned in Owolarafe *et al.,* (2007). Specific gravity is the ratio of density of a substance (fruit) to the density of a reference substance (water). Fruit volume was obtained by water

displacement method and weight was measured by using an electronic balance and fruit density (weight per unit volume) was calculated (Charrondiere *et al.,* 2012).

For determination of edible portion, peel and core content, fruits were subjected to manual peeling, coring with sharp stainless steel knife followed by subsequent weighing. All the measurements were carried out in triplicates and observations were expressed in percentage.

Chemical analysis

Edible portion of fruit was subjected to chemical analysis in triplicates, using standard procedures. Moisture content was determined by oven drying method, total ash content by gravimetric method, Total soluble solid (TSS) by using a hand refractometer, tiratable acidity (citric acid) by titrating with 0.1N NaOH in the presence of 1.0% phenolphthalein indicator, ascorbic acid by visual titration method with 2, 6-dichlorophenol- indophenols dye and total sugar by Lane and Eynon method. Pectin content estimated as calcium pectate and sugar to acid ratio was obtained as ratio of TSS and titratable acidity. For determination of crude fiber, fruit sample was treated under standardized conditions with petroleum spirit, boiling dilute sulphuric acid, boiling dilute sodium hydroxide solution and alcohol (Ranganna, 1986). pH of fruit sample (juice) was measured according to the method of AOAC (1995).

Statistical Analysis

All analyses were performed in triplicate and the results were expressed as mean ± SD. Where appropriate, the results were expressed on a fresh weight basis. Student's t / z- test for comparing two sample means was performed at 5% level of confidence.

Results and Discussion

Physical properties

Physical characteristics of pear fruits viz. length, width, thickness, sphericity, aspect ratio, weight and specific gravity are used for post-harvest handling, processing, and designing of equipments. The results of physical properties of the Pear fruit are presented in Table 1.

Colour of pear fruit

Colour is a good indicator of freshness and maturity of fruit. Colour of pear fruit changed from RHS 149 C (brilliant yellowish green) at mature stage to RHS 154 B (brilliant yellowish green) at ripe stage (Table 1 & Plate 1). Similar trend in changes of colour was also reported by Arzani *et al.,* (2008) in Asian and European pear cultivars (from green colour at harvesting stage to golden brown and yellowish green colour, respectively during ripening); Pawar *et al.,* (2011) in sapota fruits (from yellowish brown at harvesting stage to brown at ripe stage), Patil *et al.,* (2010) in carambola fruits (green at young and half ripe to ripe stage).

Size of pear fruit

Size and shape of fruit determine the number of fruits that can be placed in shipping containers or plastic bags of a given size. The length of pear fruit decreased significantly from 5.67 to 5.25 cm from mature to ripe stage, respectively. This showed a decrease of 7.41 per cent in length of pear fruit during ripening. The data presented in Table 4.1 indicated a slight decrease in width and thickness (1.45 and 2.04 per cent, respectively) from mature to ripe stage which was non-significant. The width and thickness at mature stage were 5.51 and 5.38 cm, respectively whereas at

ripe stage it was 5.43 and 5.27 cm, respectively. Decreasing trend in size parameters viz. length, width and thickness, obtained during ripe stage of pear fruit may be attributed to the loss of moisture due to respiration and transpiration during ripening process. The present findings of decreasing trends are supported by Pawar (1988) and Bhajipale (1997) in *karonda* for its length and diameter.

Shape of pear fruit

Sphericity is an expression of a shape of a solid relative to that of a sphere of the same volume while the aspect ratio relates the width to the length of the fruit which is an indicative of its tendency toward being oblong in shape. The sphericity and aspect ratio at mature stage were 97.49 and 97.66 per cent, respectively. At ripe stage a significant increase in sphericity (101.67 per cent) and aspect ratio (104.44 per cent) was observed. The per cent increase in sphericity and aspect ratio in comparison to mature stage was 4.29 and 6.94 per cent, respectively. These changes may be due to significant decrease in length because sphericity and aspect ratio are inversely proportional to length of fruit.

Weight of pear fruit

Weight is one of the most important physical index of maturity in fruit as well as most of the vegetables.The average fruit weight was101.26 g (range 67-114 g) at mature stage and 100.8 g (range 84-115 g) at ripe stage.

There was slight decline in weight of pear fruit observed towards ripening, however it was not significant. Similar findings for decreasing trend in weight during ripening of sapota fruits were reported by Pawar *et al.,* (2011).

Volume of pear fruit

The volume also showed similar trend as that of weight of pear fruit. Slight decrease in volume was recorded at ripe stage (96.18 ml^3) in comparison to volume at mature stage (100.24 ml^3) as shown in Table.1. However this difference was not significant and it might be due to decrease in size of fruit. These results were in agreement with the results reported by Pawar *et al.,* (2011) in sapota fruits.

Density of pear fruit

The density of fruit at mature stage was 1.02 g/ml^3 and 3.92% increase in density was observed at ripe stage (1.06 g/ml^3).

Increase in specific gravity during ripening indicated that the decrease in weight of fruit was lesser than the corresponding decrease in its volume.

Specific gravity of pear fruit

Specific gravity of fruit is related to their internal characteristics such as dry matter, soluble solids or physical disorders. Therefore it is used as grading index for fruits and vegetables. The specific gravity of pear fruit was increased by 2.88 % significantly from 1.04 to 1.07 at mature to ripe stage, respectively. Similar observations have been reported for *karonda* fruit by Joshi *et al.*, (1986) and Pawar (1988) and in case of sapota fruit by Pawar (2011).

Edible portion, peel and core content

The edible portion of most fruits is the fleshy part of the pericarp or vessel surrounding the seeds. Edible portion in pear fruit at mature stage was 58.37 % and a slight but non-significant increase was observed at ripe stage (60.07 %).

Table.1 Physical properties of pear fruit (on the basis of whole fruit weight)

Physical properties		Number of observations (*n*)	Mature stage			Ripe stage			Difference	Change over mature stage (per cent)	t / z-value[#] ($p \leq 0.05$)
			Range	Mean	SD	Range	Mean	SD			
Colour		50	RHS 149 C (Brilliant yellowish green)			RHS 154 B (Brilliant yellowish green)			-	-	-
Size	Length (cm)	50	4.97-6.6	5.67	0.41	4.2-6.21	5.25	0.51	-0.42	-7.41	4.624*
	Width (cm)	50	4.96-6.31	5.51	0.34	4.3-6.45	5.43	0.43	-0.08	-1.45	1.057
	Thickness (cm)	50	4.7-6.2	5.38	0.34	4.3-6.36	5.27	0.43	-0.11	-2.04	1.381
Shape	Sphericity (per cent)	50	86.59-107.59	97.49	5.14	87.05-120.43	101.67	7.63	4.18	4.29	-3.213*
	Aspect Ratio (per cent)	50	81.81-118	97.66	9.01	73.16-140	104.44	13.19	6.78	6.94	-3.00*
Fruit Weight (g)		50	67-114	101.26	8.64	84-115	100.8	7.27	-0.46	-0.45	-0.288
Volume (ml^3)		10	99.2-101.2	100.24	0.73	87.8-101.2	96.18	5.85	-4.06	-4.05	-2.18
Density (g/ml^3)		10	1.018-1.023	1.02	0.002	1.02-1.12	1.06	0.04	0.04	3.92	2.68*
Specific gravity		10	1.033-1.038	1.04	0.002	1.03-1.13	1.07	0.04	0.03	2.88	2.68*
Edible portion (per cent)		3	58.6-58.8	58.37	0.59	58.6-60.9	60.07	1.27	1.7	2.91	-4.08
Peel content (per cent)		3	12.1-15.2	13.5	1.57	11.9-13.8	12.93	0.96	-0.57	-4.22	1.36
Core content (per cent)		3	27.1-29.1	28.13	1.00	26.0-27.6	27.0	0.87	-1.13	-4.02	1.37

*significant difference; SD= standard deviation; [#]t-value for $n \leq 30$ and z-value for $n > 30$

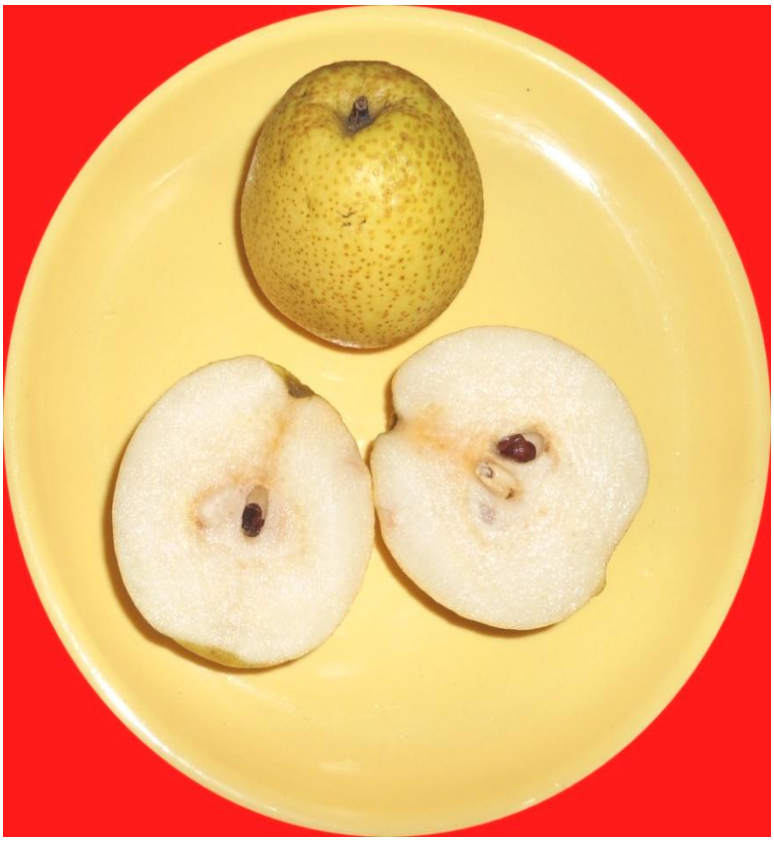
Table.2 Chemical properties of pear fruit (per 100 g edible portion)

Chemical Properties	Mature stage		Ripe stage		Differ-ence	Change over mature stage (per cent)	t-value ($p \leq 0.05$)
	Mean	SD	Mean	SD			
Moisture (per cent)	86.59	0.32	84.84	0.25	-1.75	-2.02	9.014*
Total ash (per cent)	0.33	0.02	0.28	0.02	-0.05	-15.15	6.047*
pH	4.10	0.01	4.45	0.04	0.35	8.54	-14.85*
TSS (°Brix)	12.33	0.58	14.0	0.00	1.67	13.54	-5.00*
Titrable acidity (per cent)	0.47	0.07	0.34	0.07	-0.13	-27.66	1.73
Sugar/ acid ratio	34.61	11.23	42.53	10.52	7.92	22.88	-1.4
Ascorbic acid (mg/100g)	5.13	0.44	4.55	0.00	-0.58	-11.31	2.27
Pectin content (per cent)	0.69	0.02	0.45	0.03	-0.24	-34.78	11.46*
Crude fibre (per cent)	2.98	0.10	2.87	0.06	-0.11	-3.69	2.65
Total sugar (per cent)	7.01	0.14	9.85	0.13	2.84	40.51	-20.8*
Reducing sugar (per cent)	4.02	0.06	8.67	0.07	4.65	115.67	-121.77*
Non reducing sugar (per cent)	2.99	0.08	1.19	0.21	-1.8	-60.20	12.17*

*Significant difference; #*n*= 3

Plate.1 Pear fruit at mature /140 DFFB (A) and ripe stage/170 DFFB (B)

A



B

Similarly, peel and core contents of pear fruit were not affected significantly by ripening. Peel and core contents were 13.5 and 28.13 % at mature stage and a slight decrease in corresponding terms was observed at ripe stage i.e. 12.93 and 27.0 %, respectively. Increase in edible portion may be due to softening of fruit that reduced the loss of edible portion with peel and core during peeling and coring. Decrease in weight of skin observed at over ripe stage might be the impact of maximum moisture loss from skin (Pawar, 2009).

Chemical properties

Results of chemical parameters viz. moisture, total ash, pH, total soluble solids, titrable acidity, sugar/ acid ratio, ascorbic acid, pectin, crude fibre, total sugar, reducing and non-reducing sugar of pear fruit are presented in Table 2.

Moisture content

Moisture content determines the shelf life of fruits. It provides turgor pressure to fruits and maintains its texture.

The moisture content of fruit at mature stage was 86.59% and decreased significantly by 2.02 % at ripe stage (84.84%). The decline in moisture could be attributed to the loss of moisture through respiration and transpiration. Similar findings were reported by Roy and Pandey (1983) and Joshi (1983) in mango cv. Dasheri and Alphonso, respectively; Shinde (1993), Raut (1999) and Pawar (2009) in sapota fruits.

Total ash

A significant decrease of 15.15 % was noticed in total ash content of pear fruit from mature (0.33 %) to ripe stage (0.28 %).

pH

Fruits contain organic acids that provide tartness to the fruits and slow down bacterial spoilage by lowering the pH. It is evident from the data presented in Table.2 that pH of pear fruit was significantly increased at ripe stage (4.45) from 4.1 at mature stage. Results showed 8.54 per cent increase in pH of pear fruit at ripe stage over mature stage. The increase in pH observed at ripe stage of pear fruit may be attributed to the decrease in acidity during ripening. Similar increasing trend in pH of sapota fruit was reported by Pawar (2009).

Total soluble solids (TSS)

TSS content of pear fruit increased significantly by 13.54% from 12.33 °Brix (mature stage) to 14.0 °Brix (ripe stage). This happened because starch was converted to sugars, and the complex sugars became simple ones during ripening (Arroxelas *et al.,* 2001).

Similar pattern in TSS were reported by Arroxelas *et al.,* (2001) in bilimbi fruits and Pawar (2009) in sapota fruits.

Titrable acidity

Acidity and sugars are two main elements which determine the taste of fruit. It could be revealed from the data presented in Table.2 that there was no significant difference in titrable acidity content of pear fruit at these two stages of ripening i.e. 0.47 and 0.34 per cent at mature and ripe stage, respectively. The decrease in acidity observed at ripe stage may be attributed to the oxidation of organic acids for meeting increased energy demands of ripening process (Hulme, 1970). A similar trend of change in acidity was observed in sapota fruits by Pawar (2009).

Sugar/ acid ratio

Sugar/ acid ratio in fruit was slightly increased by 22.88 %, as decrease in acidity was observed at ripe stage. However this change was not significant. A change in sugar/acid ratio was 34.61 to 42.53 from mature to ripe stage, respectively. These changes might be due to increase in sugar content and decrease in acid content.

Ascorbic acid

The data revealed that ascorbic acid content of pear fruit was decreased slightly (11.31 per cent) from 5.13 mg/100 g at mature stage to 4.55 mg/100 g at ripe stage. However, this change was non-significant.

Pectin

Pectin maintains turgidity and texture of fruits. On mild hydrolysis it yields water soluble pectin which can form gels with sugar and acid. High pectin content was noticed at mature stage (0.69 per cent) which was significantly decreased at ripe stage (0.45 per cent). The decline in pectin content over mature stage was 34.78 per cent.

Crude fibre

A decreasing trend was observed in crude fibre from mature stage (2.98 per cent) to ripe stage (2.87 per cent). However, there was no significant difference with respect to fibre content in pear fruit at these two stages of ripening and change was only 3.69 per cent.

Total sugar

During the development of the flesh of a fruit, carbohydrate is deposited as starch, which is later transformed into sugars during

the ripening process. The progression of the ripening process leads to increase in sugar levels. The data from Table.2 showed similar increasing trend of total sugars as that of TSS. The total sugar recorded at mature stage (7.01 per cent) was significantly increased at ripe stage (9.85 per cent). Change in total sugar over mature stage was 40.51 per cent. The results of this investigation for total sugar in pear fruit are in agreement with the results obtained by Pawar (2009) in sapota fruits.

Reducing & non- reducing sugar

As that of TSS and total sugar, the reducing sugar also showed significant increasing trend from mature stage (4.02 per cent) to ripe stage (8.67 per cent). This increase was two times in comparison to reducing sugar at mature stage. Similar results were reported by Pawar (2009) in sapota fruits. Non- reducing sugar was significantly decreased from 2.99 per cent (mature stage) to 1.19 per cent (ripe stage), with correspond to reducing sugar. Decrease in non-reducing sugar over mature stage was 60.2 per cent.

The chemical composition of edible fruits may differ according to maturity. The composition of pear fruits at two stages of maturity has been studied which revealed a large variation in the physical and chemical parameters. Physico -chemical properties with non-significant changes noted in the present study despite of its maturing stages include fruit width, thickness, weight, volume, density, edible portion, titrable acidity, ascorbic acid and crude fibre. Sphericity, aspect ratio, specific gravity, Reducing sugars, total sugars, TSS and pH were increased with maturity whereas moisture, total ash, pectin and length of fruits were decreased significantly. A significant decrease in chlorophyll content was observed in ripe fruits, in comparison to mature ripe fruits, which was indicated by RHS 154 B (brilliant yellowish green) colour of fruit at ripe stage. Decreased pectin content in ripe stage indicates that fruits at mature stage would be good for making jam and jellies, which require pectin essentially for gel formation with sugar.

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