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Effect of thermal processing on quality attributes of canned musk melon fruits

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Abstract
Muskmelon (*Cucumis melo* L) is an important tropical fruit widely cultivated in India. A study was conducted to study the Effect of thermal processing on quality attributes of canned musk melon fruits. The heat penetration characteristics and F_0 values of canned and retort pouched muskmelon pulp is 5.82, 6.50 and 6.62 min in the muskmelon pulp samples processed in cans having pH of 3.8 (T_1), 4.0 (T_2) and 4.2 (T_3) respectively. The TSS of fruit pulp ranged between 16 and 17 °brix. The acidity of the processed fruit pulp was found to be 2.05 (T_1), 1.94 (T_2) and 1.68 (T_3) per cent in cans. Similar to acid content, pH also showed the variation between the processed fruit pulp selected for this study. The pH varied from 3.65 to 4.08. The total sugar, β - carotene, ascorbic acid, total antioxidant activity, total flavonoids and total phenols were analysed. The mineral content of the processed muskmelon fruit pulp was ranged between 18.49 and 18.67, 0.30 and 0.33, 24.81 and 26.39 and 306.04 and 308.13 mg/100 g respectively for calcium, iron, phosphorus and potassium.

Keywords: Canning, thermal heating, quality and nutritional characters

Introduction
Muskmelon (*Cucumismelo L.*) commonly called as cantaloupe is a member of Cucurbitaceae family which is a commercially important fruit cultivated throughout the world. In India, muskmelon occupies an area of about 36.70 thousand hectare with annual production of about 760.81 thousand metric tonnes (Indian Horticulture Database, 2015).
Melon is one of the most widely consumed fruits and stands fourth among the most consumed fruits in the world as source of food. Muskmelon has a high commercial value because of its peculiar sensory and nutritional characteristics (Venkatesan, Reddy, & Senthil, 2016) [9]. High moisture content and nutrients availability and favorable pH are more vulnerable to the infestation of pathogenic fungi, which in addition to fungal rots, makes the fruits unsound for human (Parveen S., 2014) [6]. Because of this shelf life duration of the fruit is reduced. In order to give maximum returns to farmers and to curtail post harvest losses during glut season, in this study an effort was taken to extend the shelf - life of muskmelon by preserving its pulp by canning.

Materials and Methods
Experimental location and selection of fruits
A study was conducted at Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu. A fully mature, firm and ripened muskmelon fruit (*Cucumis melo* L. - cultivar Namthari) was purchased from the local market in Madurai city and was used on the same day.

Physico - chemical characteristics of musk melon fruit
The physico - chemical characteristics of the selected fresh musk melon fruit *viz.*, fruit weight, fruit length, fruit width, pulp weight, pulp yield, color values, total soluble solids, titratable acidity, pH, ascorbic acid, reducing sugar, total sugar, β - carotene, total antioxidants, total phenols, total flavonoids, calcium, iron, phosphorous and potassium were analyzed as per the standard procedure.

Preparation of musk melon fruit pulp
The selected musk melon fruits were washed under running water and the inedible portion was peeled off by using a stainless steel knife. The peeled fruit was halved into two portions and its seeds were scooped out. The fruit was cut into small pieces and pulped in the mixie. The pulp was filtered through a sterilized nylon net. The TSS was adjusted into 15º brix by using sugar, whereas pH content of the pulp was adjusted into different levels *viz.*, 3.8, 4.0 and 4.2

respectively by using citric acid. The fruit pulp was heated under steam at 100º C for 10 min. to inactivate the enzymes. The pre treated musk melon fruit pulp was utilized for canning studies.

Canning of musk melon fruit pulp

The heated musk melon fruit pulp was hot filled in the sterilized cans (SR) leaving a head space of 3 cm. The filled cans were partially seamed and exhausted till the centre of can reached to 88 ºC. The exhausted cans were double seamed and processed at 121 ºC for a period of 10 min. Heat penetration studies were carried out by positioning the thermocouples at different point indicate the heating to be by convection. The F_0 value was calculated from the temperature and time history. The processed cans were cooled at room temperature and surface dried.

Thermal processing calculation

Processing time required for canned and retort pouched musk melon fruit pulp at different pH level was calculated by improved graphical method (Ramaswamy & Singh, 1997) [7]. Lethal rates at the temperature of the heat penetration curve during heating and cooling were calculated using the expression:

B = Fh log (Jch Ih/g)

Where,
B = Process time (min.)
Fh = Heating rate index
Jch = lag factor
Ih = Initial temperature difference (ºC)
G = Tr-T
Tr = Retort temperature
T = Product temperature

Results and Discussion

Physico - chemical characteristics of muskmelon fruit

The physico - chemical characteristics of fresh muskmelon fruit was analyzed and presented in Table 1. The selected fruit was oblong in shape, the outer skin was creamish yellow in colour. The edible inner portion was yellowish orange in colour with pleasant natural muskmelon fruit flavour and highly acceptable in taste. The physical characteristics of muskmelon fruit such as weight, length and width was 1.10 kg, 10.40 cm and 16.20 cm respectively. The pulp weight and pulp yield was 649.0 g and 55.96 per cent respectively. The chemical characteristics of muskmelon fruit was moisture - 91.08 per cent, pH - 5.60, acidity - 0.128 per cent, TSS - 6.0 ºbrix, total sugar - 5.58 per cent, reducing sugar - 4.0 per cent, β-carotene - 1215 µg/100 g and ascorbic acid - 33.32 mg/100 g respectively.

The results obtained where in accordance with findings of other researchers given below. Rashid & Mahmood, (2004) [8] evaluated the chemical characteristics of musk melon fruit. Fruit pulp contained 92.9 per cent water, 5.0 per cent carbohydrates, 1.0 per cent protein, 3420 IU of vitamin A and 33 mg vitamin C.

Muskmelon quality was largely determined by its sugar content which varied from 8 - 13per cent (TSS) with sucrose as the principal sugar, total titratable acidity of 0.15 per cent and pH of 5.2 (Padín, Goitia, Hernández, & Leal, 2012) [4]. Similarly (Parveen, Azhar Ali, Asghar, Rahim Khan, & Salam, 2012) [5] also reported that muskmelon quality was determined by its sugar content which varied from 8 to 13 per cent (TSS) with a total acidity of 0.13 to 0.21 per cent.

Heat penetration studies on muskmelon fruit pulp

The heat penetration characteristics and F_0 values of canned and retort pouched muskmelon pulp are illustrated in Fig.1 to 3. From the results it was found that F_0 values were 5.82, 6.50 and 6.62 min in the muskmelon pulp samples processed in cans having pH of 3.8 (T_1), 4.0 (T_2) and 4.2 (T_3) respectively.

The reduction of heating time while using pouches has been reported by a number of workers (Lampi, 1977) [2]. (Mohan, Ravishankar, Srinivasa Gopal, & Bindu, 2008) [3] studied the thermal processing of prawn kuruma in retortable pouches and aluminium cans. They reported that F_0 values was very slightly high in cans (8.10 - 8.43). Similar results were also noted in the present investigation too.

Chemical characteristics of thermally processed muskmelon fruit pulp

The chemical characteristics of processed muskmelon fruit pulp in cans were analyzed and presented in Table 2. The thermally processed muskmelon fruit pulp in all the treatments showed variations in the nutrient content between the treatments and in the packaging materials. The processed muskmelon fruit pulp was dark yellowish orange in colour with natural muskmelon fruit flavour, moderately viscous and highly acceptable in taste. The TSS of fruit pulp ranged between 16 and 17 °brix. The acidity of the processed fruit pulp was found to be 2.05 (T_1), 1.94 (T_2) and 1.68 (T_3) per cent in cans. Similar to acid content, pH also showed the variation between the processed fruit pulp selected for this study. The pH varied from 3.65 to 4.08.

The total sugar content of T_1, $T_2$and T_3 of cans were 13.06, 13.24 and 14.51 per cent respectively. The β - carotene content of all the processed fruit pulp was found to be more or less similar and ranged between 1123 and 1149 µg/100 g. Ascorbic acid content of the fruit pulp treated with low pH (3.8) - T_1 showed higher values (30.10 - 30.11 mg/100 g) followed by T_2 (29.13 - 29.15 mg/100 g) and T_3 (28.01 - 28.06) mg/100 g. The maximum total antioxidant activity was observed in CT_1 (60.19 mg/100 g). The muskmelon fruit pulp contained slightly higher total flavonoids and total phenols in CT_1. The mineral content of the processed muskmelon fruit pulp was ranged between 18.49 and 18.67, 0.30 and 0.33, 24.81 and 26.39 and 306.04 and 308.13 mg/100 g respectively for calcium, iron, phosphorus and potassium. A slight change in the colour values (L*a* and b*) of the processed muskmelon fruit pulp was noted between the packaging materials and also in the treatments. The colour values varied from 101.00 - 101.08, 3.65 - 3.76 and 23.10 - 23.15 respectively for L*a* and b*. Among all the processed muskmelon fruit pulp, the sample processed in cans with pH 3.8 (CT_1) contained higher level of various nutrients with special reference to vitamin C and β - carotene.

Similar results were also observed by researchers of same investigation. Dewanto, Wu, Adom, & Liu, (2002) [1] studied the changes in the total antioxidant activity of thermally processed tomatoes. They observed that the antioxidant activity of raw tomatoes was 4.13 ± 0.36 µml of vitamin C equiv/g of tomato, with heat treatment at 88 °C for 2, 15 and 30 min. The total antioxidant activity significantly increased to 5.29 ± 0.26, 5.53 ± 0.24 and 6.70 ± 0.25 µml of vitamin C equiv/g of tomato respectively (p> 0.01).

Vijayanand, Deepu, & Kulkarni, (2015) [10] analyzed the physico - chemical characteristics of mango pulp before and after canning.

They reported that the processed pulp contained 17.2 ° brix - TSS, 3.8 - pH, 0.42 per cent - acidity, 2.3 per cent - reducing sugar, 13.1 per cent total sugar and 3279.9 µg/100 g of total carotenoids.

Conclusion

The outcome of research findings shows that the processing of muskmelon fruit pulp withholds all the nutritional values of the fruit for longer time under storage. Hence this will be the better way to reduce the post harvest loss and this canned pulp can also be utilised in preparation of many value added products.

Table 1: Physico - chemical characteristics of muskmelon fruit

Characteristics	Values
Fruit weight (g)	1160.00
Fruit length (cm)	10.40
Fruit width (cm)	16.20
Pulp weight (g)	649.00
Percentage pulp yield	55.96
Moisture (%)	91.08
pH	5.60
Acidity (%)	0.128
TSS (ºbrix)	6.00
Total sugar (%)	5.58
Reducing sugar (%)	4.00
β-carotene (µg /100g)	1215
Ascorbic acid (mg/100g)	33.32
Total antioxidant activity (mg / 100g)	68.36
Total flavonoids (µg RE/g extract)	2.17
Total phenols (mg GAE/g extract)	3.41
Calcium (mg/100g)	19.50
Iron (mg/100g)	0.34
Phosphorous (mg/100g)	28.40
Potassium(mg/100g)	310.46
Colour values	
L*	105.78
a *	3.94
b *	24.19

Table 2: Chemical characteristics of canned muskmelon fruit pulp

Characteristics		T_1	T_2	T_3
pH		3.65	3.87	4.06
Acidity (%)		2.05	1.94	1.68
TSS (ºbrix)		16.0	16.5	17.0
Total sugar (%)		13.06	13.24	14.51
Reducing sugar (%)		5.16	5.75	6.80
β-carotene (µg /100g)		1149	1138	1126
Ascorbic acid (mg/100g)		30.11	29.15	28.06
Total antioxidant activity (mg /100g)		60.19	59.44	59.19
Total flavonoids (µg RE/g extract)		2.03	1.99	1.90
Total phenols (mg GAE/g extract)		3.09	2.94	2.91
Calcium (mg/100g)		18.67	18.60	18.53
Iron (mg/100g)		0.33	0.32	0.32
Phosphorous (mg/100g)		26.39	25.06	24.88
Potassium(mg/100g)		308.13	306.26	306.04
Color values	L*	101.08	101.08	101.02
	a *	3.76	3.73	3.69
	b *	23.15	23.14	23.12

T_1 - 3.8 pH, T_2 - 4.0 pH and T_3 - 4.2 pH

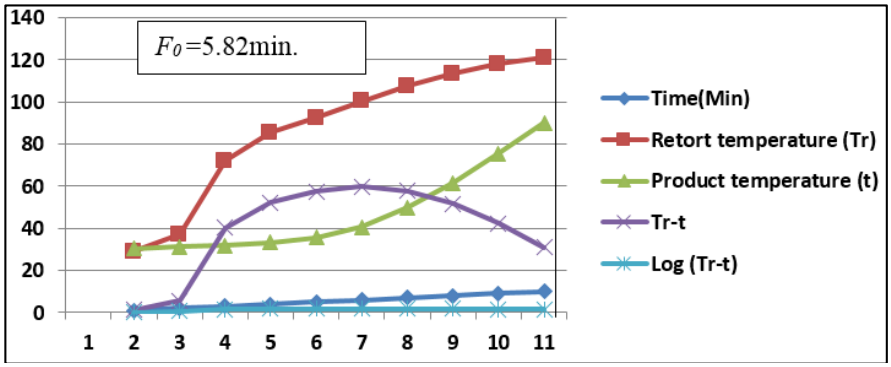

Fig 1: Heat penetration F_0 values of canned muskmelon pulp pH - 3.8 (T_1)

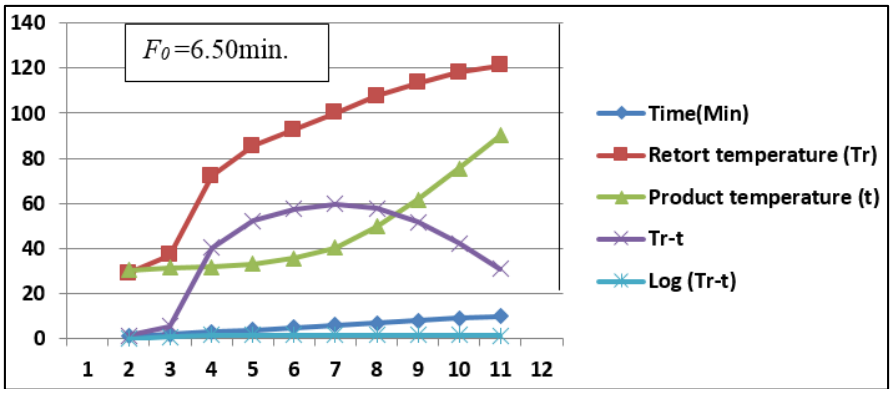

Fig 2: Heat penetration F_0 values of canned muskmelon pulp pH - 4.0 (T_2)

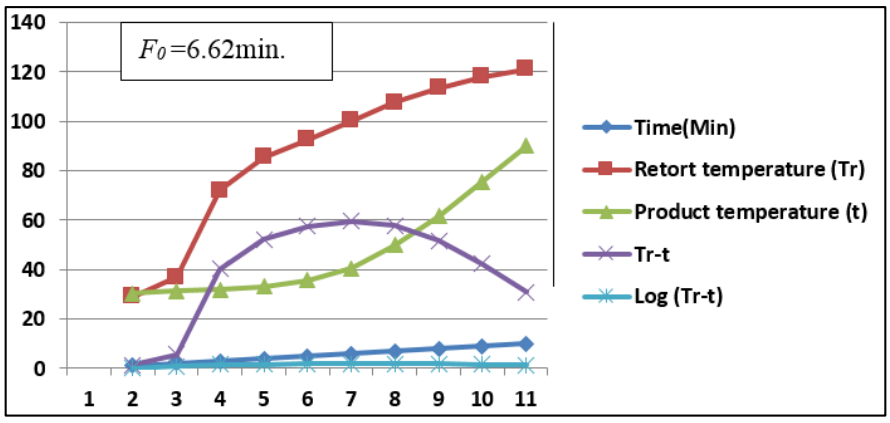

Fig 3: Heat penetration and F_0 values of canned muskmelon pulp pH - 4.2 (T_3)

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