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Physico-chemical analysis of spray dried kinnow powder

■ Dhruv Juyal
Department of Processing and Food Engineering, Punjab Agricultural University, **Ludhiana (Punjab) India**
Email : dhruvjuyal@gmail.com

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SUMMARY :

The experiments to produce powder from kinnow juice were conducted at three different blends of maltodextrin with kinnow juice such as (35:65,37.5:62.5,40:60) and with another blend of maltodextrin and sucrose with kinnow juice (40:10:50) at three feed temperatures such as 23^0 C, 26^0C and 29^0C and at three inlet temperatures such as 143^0C, 146.5^0 C and 150^0C using spray drying technique. The physico-chemical properties investigated were: total soluble solids, vit-C content, citric acid content and total sugars. The best results of total soluble solids and vitamin -C content (mg/100g) were found for 37.5:62.5 blend and total sugars (g/ml) was found for 35:65 blend. The titrable acidity (%age) was best for 40:60 blend. For another blend of (40:10:50) malto-dextrin and sucrose with juice, the titrable acidity was minimum.

KEY WORDS : Total soluble solids , Kinnow, Maltodextrin, Vit-C, Powder, Spray drying

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India is endowed with a climate that can produce wide variety of fruits (Kumar and Sagar, 2014). India is the second largest producer of fruits with a production of 93.7 MT from 6.45 Mha. In India, citrus is cultivated on 1.037 million hectares with an estimated production of 12.053 million tonnes (NHB, 2016). Citrus is one of the most important subtropical fruits in the world with total production of 115.651 million tonnes with India contributing 6.3 million tonnes (FAO, 2007). Mandarin, sweet oranges, acid lime and lemon lime are the principal citrus fruits grown in India. Citrus fruit juice is one of the most important fruit juices. Consumers like this juice because of it's nutritional value, taste and relatively low price. Fresh citrus juices are a good source of vitamin C, B1, folic acid, dietary fibre and other bio active components such as carotenoids and flavonoids (Nagy *et al.*, 1993; Brown, 2007 and Tripoli *et al.*, 2007).

Lack of appropriate post harvest technology of fruit and vegetable has been one of the most neglected fronts in agricultural development and policy till recently. India processes hardly 2 per cent of fruit and vegetables production, which must be increased in order to avoid market glut, ensure income security to farmers and bring nutritional security (Sagar and Suresh Kumar, 2007). There are several steps and components of processing and preservation of fruit or other perishable products and among them drying is the most important (Das and Dutta, 2013). Drying is the oldest known method of preserving

food. Historically, food was dried in the sun. Drying has many advantages. By removing most of the moisture from a food, micro-organisms can't grow in it.

Fruits and vegetables are dried to enhance storage stability, minimize packaging requirement and reduce transport weight (Meena *et al.*, 2014).

Kinnow is one of the major citrus fruit crop of India and major fruit crop of Punjab. Kinnow is a cross of 'King' (Citrus nobilis) x 'willow leaf'(Citrus deliciosa). The kinnow is a high yield mandarin hybrid cultivated extensively in under Punjab region of India and Pakistan. The area under cultivation of kinnow is 49,356 ha with production of 11,40,312 Mt.(Anonymous, 2016). The availability of fresh kinnow juice is seasonal and localized. Therefore, for its efficient utilization and to enhance its availability during the off season and in other locations, there is need to process it immediately into suitable form not only for preservation but also for ready reconstitution for consumption (Juyal *et al.*, 2015).

Spray drying is one such modern technology that can serve the purpose for dehydration of fluid foods into powder form. Fruit pulp or juice can be spray dried with some additives and others as pure fruit. Fruits that have been spray dried include tomatoes, bananas, citrus, apricots, peaches, pumpkin, mango and boysenberry (Masters, 1985).

De Moura Neto *et al*. (2015) studied that dehydration is an important alternative to making the most of the use the surplus of production and take advantage of the seasonality of tropical fruits. Thus, this study aimed to evaluate the physico-chemical composition of the yellow mombin pulp (*Spondia mombin* L.) powder, obtained by spray drying. The physico-chemical analyzes of the yellow mombin powder were: soluble solids, titratable acidity and ascorbic acid with all results in accordance with the current legislation. The pH values for the powders did not show significant differences in ºBrix and ascorbic acid. Only acidity presented differences at 5 per cent probability ($p<0.05$).

Mahendran (2010) studied the effect of different drying methods and the addition of drying aids on the physico-chemical properties of dehydrated guava concentrate. Instant guava drink powder samples were obtained by dehydrating the concentrated guava juice using freeze drying, spray drying and tunnel drying techniques. Guava juice at 10.5°Brix was used to prepare the fruit powders. A significant reduction ($p<0.05$) in titratable acidity of 0.22 per cent as citric acid and an increase in pH of 0.44 after drying of guava juice indicated that some acids were lost during the drying process. The oxidative loss of ascorbic acid was considerably lower in freeze drying (18.8%) compared to tunnel drying (32.2%).

Saikia *et al.* (2015) studied that fruit juices from Khasi mandarin orange, watermelon, carambola and pineapple were spray dried with 20 per cent maltodextrin and studied for physico-chemical properties. Khasi mandarin orange gave the highest yield (85.27%). Viscosity of the feed sample varied among samples. pH was in the acidic range and titratable acidity was highest in carambola (0.70%).

Sharma *et al*. (2001) conducted an experiment during 1998-99, to determine the suitability of hill lemon (Citrus pseudolimon Tanaka) fruits which was evaluated for the preparation of some new products, *viz.*, juice concentrate, foam mat dried juice powder. The lemon juice after enzymatic clarification was concentrated to various folds (°Brix) using evaporative vacuum concentration. The juice concentration upto 45°Brix was optimized, as it experienced negligible changes in quality during evaporation. Out of different combinations, the foam mat drying of juice concentrate (45°Brix) yielded a juice powder of 57.75 per cent acidity (citric acid) and 185.88 mg/100 ml ascorbic acid besides other nutrients.

Sharma *et al*. (2009) Enzymatically clarified lemon juice, with and without cation exchange resin (Dowex 50W) treatment, which was further concentrated to 60° Brix in a vacuum evaporator and converted into juice powders by foam mat drying technique. During 9 months storage, powders suffered losses in total sugars, total amino acids and ascorbic acid. Powders pulverized with cane sugar suffered overall lesser changes in most of the quality parameters during 9 months of storage.

The present study was conducted on physico-chemical properties of spray dried kinnow powder and fresh kinnow juice so as to analyse the effect of spray drying on physico-chemical properties.

EXPERIMENTAL METHODS

Fresh fully ripened kinnow fruits were procured from the local market in Ludhiana during the months of November 2009 to March 2010. These were cleaned thoroughly with running water so as to remove the adhered dirt, air-dried and stored in a refrigerator. Commercially

available drying agents Maltodextrin (DE-20) and sucrose (A.R.) procured from the local supplier were used in the study. Kinnow mandarin juice was extracted through manually operated pressure type juice machine. The juice so obtained was filtered by using a multipurpose strainer consisting of double walled nylon woven mesh having 44 openings/inch^2 (Juyal *et al.*, 2015).

The kinnow juice sera so obtained was heated in a tray dryer at three feed temperatures such as 23^0, 26^0 and 29^0C. The kinnow juice sera so obtained was analysed for physico-chemical attributes such as tss (^{0}Brix), Titrable acidity (% age), ascorbic acid (mg/100g), total sugars (g/ml). The kinnow powder was prepared through spray drying technique by addition of maltodextrin with kinnow juice into three blends such as (35:65, 37.5: 62.5,40:60) and with another blend of maltodextrin and sucrose with kinnow juice (40:10:50) as shown in Table A.

The manufactured kinnow powder was analysed for its physico-chemical properties such as:

Total soluble solids:

The powder was reconstituted in the ratio of 1: 5 (specified by Foods and Inns Limited, Mumbai for spray dried lemon juice powder). *i.e*. 2 g of powder was dissolved in 10 ml of water and per cent T.S.S. were determined with the help of 0-32 ºBx Erma hand refractometer. One or two drops of reconstituted juice were put on the sample plate and read the per cent total soluble solids on the scale. The reading was normalised against a standard temp. of 20°C (A.O.A.C., 1970).

Estimation of total sugars:

In this 1 g of powder was weighed in an Afcoset Electronic balance FX-320 with maximum capacity of 60 g and an error of .001 g. It was further dissolved in 100 ml of distilled water, from this solution 1ml of extract was dissolved in 10 ml of distilled water. Further, to 0.1 ml of above extract, added 0.9 ml of distilled water to make it 1 ml. To this added 1 ml of phenol solution followed by addition of 5 ml of sulphuric acid. The final solution was kept to cool for 20 minutes. In the mean

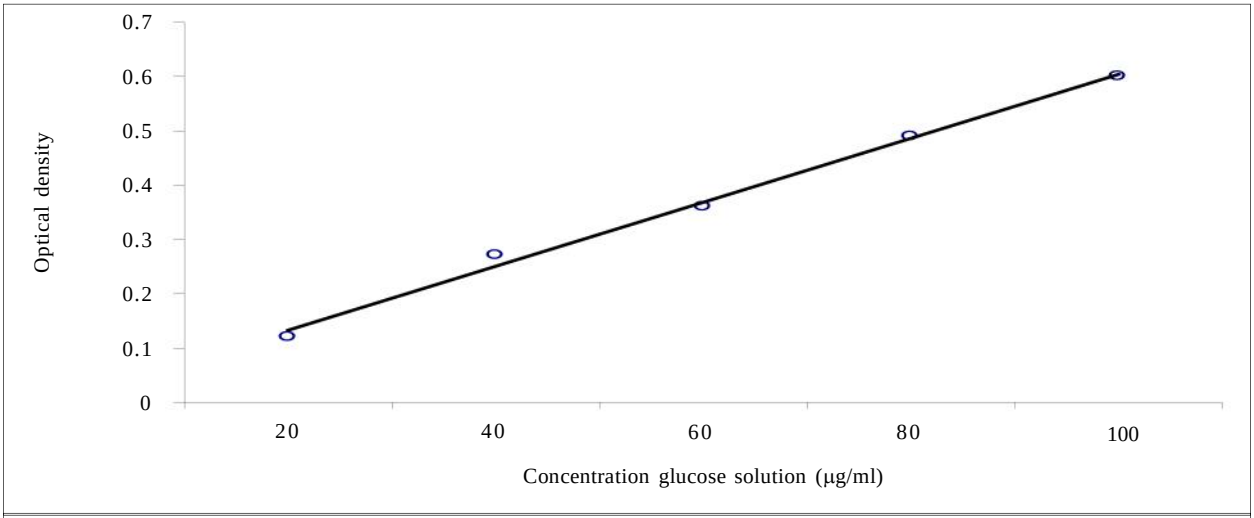

Fig. A : Standard curve for sugar estimation

Table A : Experimental scheme for production of kinnow juice powder

Type of fruit	Kinnow
Drying methods	Spray drying
Treatments	Physical treatment : Concentration of kinnow juice by using 3 different blends of maltodextrin with juice and maltodextrin and sucrose with juice at three inlet air and feed temperatures
Total number of samples	36
Drying conditions	Spray drying of concentrated blends was done at inlet temperature of 143^0C, 146.5^0C and 150^0C in the lab scale LSD-48 Mini spray dryer

time spectrophotometer was set to zero with blank solution. Intensity of the colour developed was measured at 490 nm against blank reagent. The concentration of total sugars (as glucose) was calculated from the standard glucose curve (20-100 mg/ml) run simultaneously (Dubois *et al.*, 1956).

Estimation of vitamin-C content:

0.5-1.0 g of powder was taken and mixed with 10-25 ml of acetic acid metaphosphoric acid solution. From the total extract 5.0 ml was taken for titration with 2-6 dichloro-indophenol (dye) till the pink colour was formed and remained for sometime. Volume of the dye used for sample titration was noted in ml (V_2) as cited below in the formula. For calculating V_1, 5.0 ml of Standard ascorbic acid solution was titrated with dye till the pink colour was formed and remained for some time. V_1 = 8.7 ml Vit-C content was calculated by the following formula:

(1 mg/Vol. of dye for Std. V_1)*(Vol. of dye for sampleV_2/5 ml)*(Total extract/Wt. of the sample)*100 in (mg/100g). (A.O.A.C., 1970).

Estimation of titrable acidity as (Citric acid anhydrous):

1-2 g of powder was weighed and dissolved in 20-25 ml of distilled water. From this solution, 1 ml of extract was taken, added to 10 ml of 90 per cent ethyl alcohol in a conical flask and mixed well by shaking. Then, titrated it against 0.1 N NaOH using five drops of phenolphthalein as an indicator till pink colour was formed. A blank was also run along with using 10 ml of alcohol in place of extract.

Calculated % of acidity as citric acid anhydrous.

Acidity % = 6.4*N*A/V *D where

N = Normality of NaOH solution

A = Vol. of standard NaOH solution used in titration in (ml).

V = Vol. of extract taken in (ml)

D = Dilution factor (A.O.A.C., 1970).

Statistical analysis :

The data obtained for physico-chemical properties was analysed for measures of central tendency and measures of dispersion using MS-EXCEL 2007.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physico-chemical attributes of fresh kinnow juice:

The fresh kinnow juice extracted was evaluated for it's chemical quality attributes using standard procedures.

Total soluble solids:

As referred to Table 1, the maximum mean value for total soluble solids was at 37.5:62.5 blend as 21.67 per cent with S.D. 0.46 for all the three Inlet and feed temperatures. The value for 40:10:50 (Maltodextrin: sucrose:juice) blend was 21.22 per cent and S.D. 1.64 for all the three Inlet and feed temperatures.

Table 1 : Total soluble solids at all the three blends applied

Blend (Maltodextrin:juice)	Mean (%)	Standard deviation	Co-efficient of variation	Variance	Kurtosis	Skewness
35:65	20.89	0.47	2.26	0.22	1.43	-0.16
37.5:62.5	21.67	0.46	2.12	0.21	0.27	0.65
40:60	20.45	0.49	2.42	0.24	-0.75	-0.48
40:10:50 (Maltodextrin :sucrose:juice)	21.22	1.64	7.74	2.70	2.72	1.26

Table 2 : Total sugars at all the three blends applied

Blend (Maltodextrin:juice)	Mean (g/ml)	Standard deviation	Co-efficient of variation	Variance	Kurtosis	Skewness
35:65	0.57	0.13	23.52	0.512	-1.18	-0.30
37.5:62.5	0.33	0.09	27.78	0.0085	1.43	1.60
40:60	0.28	0.04	14.65	0.0017	0.0011	-0.97
40:10:50 (Maltodextrin .:sucrose:juice)	0.49	0.06	13.92	0.0047	-1.44	0.59

Total sugars:

As referred to Table 2, the maximum mean value for total sugars was at 35:65 blend as 0.57 with S.D. 0.13 for all the three Inlet and feed temperatures. The value for 40:10:50 (Maltodextrin:sucrose:juice) blend was 0.49 and S.D. 0.06 for all the three Inlet and feed temperatures. The mean total sugars decrease as the proportion of kinnow juice in the blend decreases. The mean total sugars increase due to the addition of sucrose as compared with 37.5:62.5 and 40:60 blend but lesser than 35:65 blend due to lesser amount of kinnow juice in the blend.

Vit-C content :

As referred to Table 3, the maximum mean value for Vit-C content was at 37.5:62.5 blend as 63.81 with S.D. 3.10 for all the three Inlet and feed temperatures. The value for 40:10:50 (Maltodextrin:sucrose:juice) blend was 51.47 and S.D. 4.29 for all the three Inlet and feed temperatures. The Vit-C content decreased at this blend as compared to all the three blends because of decrease in proportion of juice content.

Titrable acidity in percentage as (Citric acid anhydrous):

As referred to Table 4, the maximum mean value for titrable acidity in (%age) was at 40:60 blend as 4.81 with S.D. 0.37 for all the three Inlet and feed temperatures. The value for 40:10:50 (Maltodextrin: sucrose: juice) blend was 3.91 and S.D.0.52 for all the three Inlet and feed temperatures.

Effect of spray drying on physico-chemical properties:

As referred to Table 5, the percentage increase in TSS was 72 per cent, in total sugars it was 24 per cent, in Vit-C content it was 73.5 per cent and in titrable acidity it was 189.76 per cent of kinnow powder as compared to fresh kinnow juice values, respectively.

Conclusion:

The physico-chemical properties of kinnow powder were total soluble solids as 21.67 per cent, total sugars as 0.57(g/ml), Vit-C content as 63.81(mg/100g) and titrable acidity as 4.81 per cent. There was slight increase in total sugars and higher increase in TSS and Vit-Content and an

Table 3 : Vit-C content at all the three blends applied

Blend (Maltodextrin:juice)	Mean (mg/100g)	Standard deviation	Co-efficient of variation	Variance	Kurtosis	Skewness
35:65	62.28	1.33	2.13	1.77	-0.05	-0.85
37.5:62.5	63.81	3.10	4.85	9.60	-1.26	0.039
40:60	61.76	3.12	5.06	9.77	-0.44	-0.73
40:10:50 (Maltodextrin .:sucrose:juice)	51.47	4.29	8.34	18.47	-1.18	-0.70

Table 4 : Citric acid content in percentage at all the three blends applied

Blend (Maltodextrin:juice)	Mean (%)	Standard deviation	Co-efficient of variation	Variance	Kurtosis	Skewness
35:65	4.70	0.48	10.40	0.24	-0.40	0.81
37.5:62.5	4.35	0.26	6.19	0.072	3.66	-1.67
40:60	4.81	0.37	7.84	0.14	-1.15	-0.85
40:10:50 (Maltodextrin .:sucrose:juice)	3.91	0.52	13.39	0.27	-0.60	0.48

Table 5: Percentage increase in physico-chemical properties of kinnow powder

Physico-chemical properties	Fresh kinnow juice	Kinnow powder	Percentage increase
Total soluble solids in ^{0}Brix	12.6	21.67	72
Total sugars in (g/ml)	0.46	0.57	24
Vit-C content in mg/100g	36.78	63.81	73.50
Titrable acidity in percentage	1.66	4.81	189.76

immense increase in Titrable acidity in kinnow powder.

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