DR-2064
[1-6]

RESEARCH ARTICLE Asian Journal of Dairy and Food Research

Impact of Blanching Treatments on the Physicochemical Qualities of Kinnow Peel Powder and its Utilization for Cupcake Formulation

Kashagoni Kalyani[1], Dashrath Bhati[1], Harendra[2], Deepak Maurya[2], Dinesh Baboo Tyagi[3] 10.18805/ajdfr.DR-2064

ABSTRACT

Background: This study aims to determine the effects of blanching on the physicochemical characteristics of kinnow peel powder (KPP) and its suitability for cupcake formulation.

Methods: The kinnow peels (KPs) were divided into five groups according to different blanching times at 95±5°C: 0 minutes (control), 2 minutes (T1), 4 minutes (T2), 6 minutes (T3) and 8 minutes (T4). All the blanched and control KPPs were examined for functional properties and proximate and organoleptic attributes.

Result: The findings revealed that an increased blanching time affected the functional properties of KPP and varied significantly at a 5% significance level. The titratable acidity was reduced, with T4 exhibiting the lowest value (1.03±0.010). However, with the increased blanching time, the pH, bulk density, water absorption index and oil absorption capacity were also increased and reported as 6.32, 7.05 g/cc, 4.98 gm/gm and 2.04 gm/gm, respectively. The maximum protein content was observed in T4 (7.11 gm/100 gm) and its minimum values were recorded in crude fat (1.07±0.010 gm/100 gm), crude fibre (7.15±0.030 gm/100 gm), total mineral (3.54±0.035 gm/100 gm) and carbohydrates (70.79±0.11 gm/100 gm). An increase in the blanching time positively impacted the organoleptic attributes and reduced the bitter taste of the KPP (T4), boosting the overall acceptability of KPP. Hence, T4 was selected in cupcake formulation at 0% (TCC0), 10% (TCC1), 20% (TCC2), 30% (TCC3) and 40% (TCC4). It was noted that TCC2 might be used for cupcake formulation at the industrial level.

Key words: Blanching, Muffins, Organoleptic, Physicochemical properties, Proximate composition.

INTRODUCTION

Citrus is one of the most popular fruits worldwide. The genus citrus comprises more than 162 species and belongs to the family *Rutaceae* (Samson, 1986). It is primarily grown in the USA, Brazil, Mexico, India and Argentina. Among various citrus species, kinnow was created as a hybrid of two citrus cultivars: King (*Citrus nobilis*) and Willow leaf (*Citrus deliciosa*). It was introduced in India in 1940 (Mahawar *et al*., 2019). The production of citrus in India, especially kinnow, has increased with time; presently, the total output for the year 2021–2022 (first advance estimate) of kinnow in India was 6,046 tonnes. Madhya Pradesh (Indian state) is the leading producer of kinnow, with 2,060.55 tonnes, with a share of 32.89% of the total output from India (NHB, 2022).

Kinnow is mainly processed for juice processing; therefore, it produces a yield of 45% for juice and by-products such as peels (27%), rag and pulp residue (26%) and seeds (Mahaot et al., 2016). Overall, kinnow peel (KP) generates approximately 50% of solid waste. The KP contains different bioactive compounds such as carotenoids, flavonoids, phenolic acids, among others (Safdar *et al*., 2017; Manthey and Grohmann, 2001). Flavonoids are present in higher concentrations in peels than in seeds. It also includes other phytochemicals such as ascorbic acid, hesperidin, naringin, naringenin, narirutin limonin and pectin and other phenolic compounds (Sidhu *et al*., 2016). Because of these compounds, KP also exhibits antimicrobial activities, making them effective against bacteria and fungi (Ahmad *et al*., 2006).

KP is structurally subdivided into flavedo and albedo. The flavedo is the peripheral, coloured part rich in essential oils, which causes a burning sensation in the mouth and extreme dryness in the mucous membranes upon contact. The albedo is the inner, spongy and white portion of the peel containing bitter flavanone (Akyildiz and Ağçam, 2014;

[1]Department of Horticulture, School of Agriculture, ITM University Gwalior-474 001, Madhya Pradesh, India.
[2]School of Agricultural Sciences, GD Goenka University, Sohna-122 103, Gurugram, Haryana, India.
[3]Faculty of Agriculture Sciences, Mandsaur University, Mandsaur-458 001, Madhya Pradesh, India.

Corresponding Author: Dashrath Bhati, Department of Horticulture, School of Agriculture, ITM University, Gwalior-474 001, Madhya Pradesh, India. Email: bhati.dashrath.1@gmail.com

How to cite this article: Kalyani, K., Bhati, D., Harendra, Maurya, D. and Tyagi, D.B. (2023). Impact of Blanching Treatments on the Physicochemical Qualities of Kinnow Peel Powder and its Utilization for Cupcake Formulation. Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-2064.

Submitted: 29-12-2022 **Accepted:** 03-10-2023 **Online:** 06-11-2023

Berhow *et al*., 1998). These compounds cause primary and delayed bitterness (Gorinstein *et al*., 2006) and reduce the product's acceptability among consumers (Ferreira *et al*., 2008).

Blanching helps destroy the enzymatic activity in fruits and vegetables. It also alters the organoleptic and nutritional attributes (Ben Zid *et al*., 2015). Therefore, this study aims to assess the effects of blanching on the physicochemical properties of kinnow peel powder (KPP) and its suitability in cupcake formulation.

MATERIALS AND METHODS

Procurement of kinnow and collection of peel

Ripen fruits were purchased from the local market of Gwalior in a single lot. Fruits were washed with lukewarm water followed with tap water to remove wax and all the extraneous material present on the surface of the fruits. All the fruits were wiped out with the help of tissue paper to remove the extra moisture present on the surface. Manual peeling was done to collect the kinnow peels.

Blanching of KP

The KP were divided into five groups according to their times of blanching at 95±5ºC: 0 minutes (Control), 2 minutes (T1), 4 minutes (T2), 6 minutes (T3) and 8 minutes (T4) (Fig 1). Sun-drying is one of the oldest methods and zero cost of drying as well as very much feasible to small and marginal farmers residing in Madhya Pradesh. Therefore, all the blanched KP were sundried separately and then powdered.

Assessment of functional properties of KPP

The pH and titratable acidity of the blanched KPP were analysed by the method proposed by Ranganna (2012).

Bulk density

The bulk density of the samples was calculated by the method of Okaka and Potter (1979). The powdered sample was poured into a dry and clean 25 ml measuring cylinder up to the 10 ml graduation. Continuous tapping was used to pack the powdered particles into the designated volume compactly. More powder was added until the powders reached the 10 ml graduation level. The results were expressed in g/cc.

Water absorption index

The water absorption index of the samples was assessed by the method suggested by Mateos-Aparicio *et al*. (2010). The KPP (0.5 g) was mixed with 20 ml of distilled water and left at room temperature (25°C) for 24 hours. The centrifugation was conducted for 10 minutes at 4200 rpm. After that, the sediments were collected and weighed. The results were expressed in gm/gm.

Oil-holding capacity

The method described by Zhang *et al*. (2011) was slightly modified to measure the oil-holding capacity. In total, 0.5 g of sample was combined with 5 ml of sesame oil using a vortex. It was then kept at 4°C for an hour. Next, it was centrifuged for 15 minutes at 4200 rpm. The results were expressed as gm/gm.

Swelling capacity

The approach outlined by Zhang *et al.* (2011) was used with a few minor modifications to measure the swelling capacity of samples. In a measuring cylinder, 0.4 g of precisely weighed powdered sample was added, followed by 10 ml of water. The mixture was then hydrated for 18 hours at 4°C. Next, the volume fraction and sample volume (ml) were documented.

Evaluation of proximate composition of blanched KPP

Moisture, crude protein, crude fat, crude fibre and total minerals of the samples were determined by the method suggested by AOAC (2005). The carbohydrate content was calculated using the difference (by subtracting the total percentages of moisture, crude protein, crude fibre, crude fat and ash from 100%). The energy content was measured through the physiological fuel value (Mudambi *et al*., 1989).

Organoleptic evaluation of kinnow peel powder

The blanched powder samples of KPPs were given to a 31-member panel comprising professors, assistant professors and research associates from the Department of Horticulture, ITM University, Gwalior, India, for organoleptic assessment. Organoleptic analysis was conducted to determine the flavour, aroma, texture, feeling in mouth (taste), aftertaste, bitterness and overall acceptability of the powder samples (Larmond, 1970). A single blanched KPP (T4) was selected for cupcake formulation based on the organoleptic evaluation of blanched KPP.

Development and organoleptic evaluation of the developed cupcakes

The selected blanched KPP was incorporated in the amounts of 0% (TCC0), 10% (TCC1), 20% (TCC2), 30% (TCC3) and 40% (TCC4) in the standardised recipe of cupcakes. Organoleptic evaluation of the cupcakes was determined by using a nine-point hedonic rating scale (Larmond, 1970). A 31-member panel, as mentioned above, performed the assessment.

Evaluation of proximate composition of kinnow peel cupcakes

The proximate composition of KP cupcakes was analysed by the method suggested by (AOAC, 2005). The carbohydrate content was calculated using the difference (by subtracting the total percentages of moisture, crude protein, crude fibre, crude fat and ash from 100%). The energy content was analysed by the physiological fuel value (Mudambi *et al*., 1989).

Statistical analysis

The results obtained during the investigation were statistically analysed using factorial completely randomised design in R software. The results were interpreted through the analysis of variance at a 5% significance level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The effects of blanching on KPP were analysed to determine its functional properties, organoleptic properties and proximate composition. The upcoming subsections discuss these results in detail.

Functional properties

Table 1 presents the results on the functional properties of blanched KPP. The pH and acidity were found to be inversely proportional. This study's data depict the declining trend in the titratable acidity with respect to the increase in the blanching time, for example, in T4 (1.03± 0.010). The bulk density, water absorption index and oil absorption capacity in T4 were increased with an increase in the duration of blanching and were reported as 7.05±0.070 gm/cc, 4.98±0.050 gm/gm and 2.04±0.020 gm/gm, respectively. However, the swelling capacity was reduced with the increase in the blanching time, except for T3. This outcome may be attributed to experimental errors.

Mann and Aggarwal (2013) and Ojha and Thapa (2017) on the functional properties of KPP. The hot water blanching led to the swelling of the KPP. Furthermore, it resulted in an increase in the pH and a decrease in the total titratable acidity with respect to an increased blanching time. The KP is subdivided into flavedo and albedo. Blanching causes

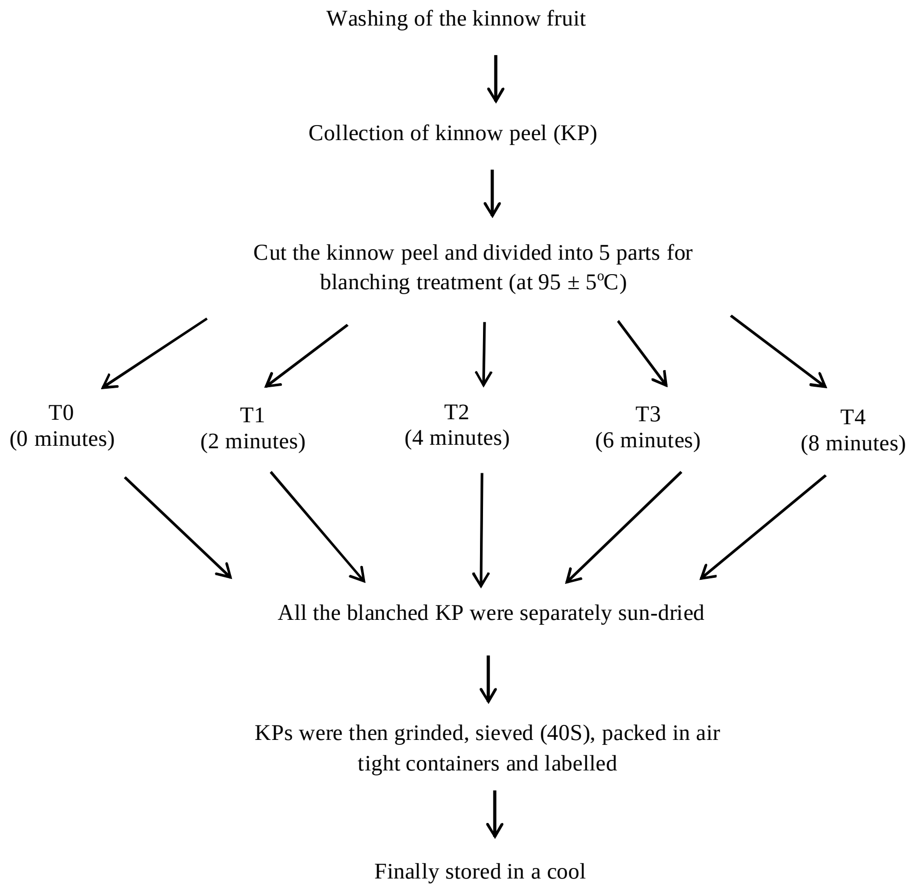

Fig 1: Processing of kinnow peel for blanching treatment.

Table 1: Functional properties of blanched KPP.

Treatments	pH	Acidity (%)	Bulk density (g/cc)	Water absorption index (gm/gm)	Oil absorption capacity (gm/gm)	Swelling capacity (%)
T0	4.22	1.28±0.021	4.35±0.067	3.53±0.056	1.34±0.021	0.50±0.009
T1	4.26	1.24±0.019	4.88±0.076	3.90±0.061	1.53±0.025	0.48±0.006
T2	5.49	1.19±0.042	6.43±0.232	4.26±0.154	1.70±0.062	0.47±0.015
T3	5.52	1.11±0.030	6.63±0.176	4.63±0.123	1.88±0.050	0.50±0.012
T4	6.32	1.03±0.010	7.05±0.070	4.98±0.050	2.04±0.020	0.45±0.003
CD @ 5%	0.384	0.084	0.451	0.314	0.126	0.032
SE (m)	0.12	0.026	0.141	0.098	0.04	0.01

cell swelling. The heat damages the cell membranes, thus making them permeable (Fellows, 2019).

Proximate composition of blanched KPP

The findings demonstrate significant differences in the proximate composition of blanched KPPs (Table 2). The blanching treatment reduced the relative composition of the blanched KPP. The blanching time was found to be inversely proportional to the crude fat, mineral and fibre contents of the blanched KPP. The highest protein content was observed in T4 (8 minutes of blanching) at 7.11±0.021 gm/100 gm, followed by T3 (6 minutes of blanching) at 6.84±0.062 gm/100 gm. The lowest protein content was observed in T0 (Control) at 6.11±0.040 gm/100 gm. The minimum ash content was recorded in T4 (3.54±0.035 gm/100 gm), followed by T3 (3.75±0.021 gm/100 gm), T2 (3.87±0.087 gm/100 gm) and T1 (4.12±0.031 gm/100 gm).

This study's results are consistent with the studies conducted by Bejar *et al*. (2011), Mann and Aggarwal (2013). The results revealed significant differences in the proximate composition of blanched KPP. The blanching treatment caused a reduction in the proximate composition of the blanched KPP. It is evident from these outcomes that the blanching time is inversely proportional to the crude fat, mineral and fibre contents of the blanched KPP. Fellow (2019) reviewed the blanching treatment and observed similar results for water-soluble components such as minerals, vitamins and other structural elements. This finding is attributed to leaching and thermal destructions. However, Puupponen-Pimia *et al*. (2003) presented contradictory results on the crude fibre content. Their study was conducted to describe the effects of blanching on 20 common vegetables and found that the fibre content may increase in the blanched vegetables.

Organoleptic evaluation of blanched KPP

Among all the blanching KPPs, the highest aftertaste parameter of KP was recorded in T4 (8 minutes of blanching) with a value of 7.48, followed by T3 (6 minutes of blanching) with a value of 7.23 (Table 3). The minimum value (6.39) of the aftertaste parameter of KP was recorded in T0 (Control). The increase in the blanching time positively improved the acceptability and reduced the bitterness of KPP. Therefore, T4 (8 mins of blanching) KPP was selected for further investigation and development of KP-incorporated cupcakes.

Ben Zid *et al*. (2015) conducted a study on the steam (60 mins at 85°C) and water blanching (10 mins at 95°C) treatment of the citrus peel. They observed that water blanching helps in the swelling of the cells and in reducing the bitterness of the citrus peel. The organoleptic evaluation of the KPP of this study also supports the study of Ben Zid *et al*. (2015).

The cupcakes were developed by incorporating T4 (8 mins of blanching) KPP in different concentrations of 0% (TCC0), 10% (TCC1), 20% (TCC2), 30% ((TCC3) and 40% (TCC4).

Organoleptic properties of blanched KP cupcakes

Table 4 shows the overall acceptability of KP cupcakes. The maximum acceptability was recorded for TCC0 (8.58±0.24) and the minimum for TCC4 (7.08±0.14). The results revealed that an increase in the concentration of KPP reduced the acceptability of the cupcakes. The study concludes that 20% of KP may be incorporated for developing nutritionally enriched cupcakes with flavour masking. Therefore, cupcake with 20% KP (TCC2) was further analysed for the proximate composition.

Table 2: Proximate composition of blanched KPP (gm/100 gm).

Treatments	Moisture	Crude protein	Crude fat	Crude fibre	Ash	CHO	Energy (K. cal)
T0	8.62±0.280	6.11±0.040	1.73±0.046	8.22±0.030	4.22±0.061	71.10±0.410	324.41±1.075
T1	9.20±0.062	6.32±0.060	1.65±0.035	7.88±0.065	4.12±0.031	70.83±0.118	323.47±0.527
T2	9.49±0.141	6.63±0.025	1.45±0.036	7.62±0.031	3.87±0.087	70.94±0.211	323.36±0.953
T3	9.98±0.060	6.84±0.062	1.24±0.026	7.35±0.030	3.75±0.021	70.83±0.170	321.85±0.215
T4	10.33±0.075	7.11±0.021	1.07±0.010	7.15±0.030	3.54±0.035	70.79±0.110	321.24±0.271
CD @ 5%	0.272	0.082	0.06	0.072	0.096	0.421	1.276
SE (m)	0.122	0.037	0.027	0.032	0.043	0.189	0.571

Table 3: Organoleptic evaluation of blanched kinnow peel powder.

Treatments	Flavour	Aroma	Texture	Mouth feel	After taste	Bitterness	Overall acceptability
T0	6.56±0.081	6.22±0.075	5.51±0.063	5.64±0.069	6.39±0.075	6.98±0.070	6.43±0.075
T1	6.81±0.104	6.56±0.101	5.87±0.092	6.09±0.092	6.66±0.101	7.23±0.191	6.61±0.101
T2	7.18±0.258	6.92±0.249	6.23±0.225	6.60±0.237	6.95±0.252	7.50±0.270	6.81±0.247
T3	7.51±0.200	7.29±0.191	6.62±0.174	7.09±0.185	7.23±0.191	7.77±0.119	7.02±0.185
T4	7.82±0.080	7.64±0.077	6.98±0.070	7.56±0.077	7.48±0.073	8.04±0.122	7.21±0.070
CD @ 5%	0.515	0.495	0.447	0.472	0.498	0.54	0.486
SE (m)	0.161	0.155	0.14	0.148	0.156	0.169	0.152

Table 4: Organoleptic properties of blanched kinnow peel cupcakes.

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
TCC0	8.46±0.304	8.39±0.304	8.44±0.304	8.64±0.309	8.98±0.324	8.58±0.24
TCC1	8.19±0.125	8.22±0.125	8.25±0.125	7.90±0.122	8.61±0.132	8.23±0.25
TCC2	8.09±0.122	8.12±0.122	7.93±0.122	7.74±0.117	7.96±0.122	7.97±0.15
TCC3	7.11±0.188	7.22±0.070	7.32±0.194	7.25±0.191	7.23±0.191	7.23±0.08
TCC4	6.87±0.070	7.03±0.185	7.09±0.070	7.22±0.070	7.17±0.070	7.08±0.14
CD @ 5%	0.577	0.575	0.581	0.581	0.604	0.604
SE (m)	0.181	0.18	0.182	0.182	0.189	0.189

Table 5: Proximate composition of blanched kinnow peel cupcakes (gm/100 gm).

Treatments	Moisture	Protein	Fat	Fibre	Ash	Carbohydrate	Energy (K.cal)
TCC0	32.42±0.451	7.28±0.498	22.57±0.082	2.81±0.062	4.56±0.114	30.32±0.482	353.53±1.682
TCC1	31.40±0.343	7.57±0.208	21.63±0.135	2.98±0.130	4.82±0.055	31.60±0.482	351.35±0.346
TCC2	30.52±0.240	7.61±0.350	20.32±0.207	3.36±0.150	5.16±0.057	33.03±0.173	345.44±1.398
TCC3	29.78±0.236	8.22±0.067	19.01±0.438	3.68±0.127	5.47±0.087	33.90±0.540	339.57±2.382
TCC4	27.93±0.951	8.40±0.139	18.03±0.110	3.90±0.070	5.72±0.055	36.05±0.976	340.07±4.084
CD @ 5%	0.942	0.538	0.424	0.206	0.141	1.073	4.247
SE (m)	0.423	0.241	0.19	0.093	0.063	0.482	1.906

Proximate composition of blanched kinnow peel cupcakes

Among all the different concentrations of blanching of KP cupcakes, the highest energy content value of the KP cupcakes was recorded in treatment TCC0 (control) with values of 353.53 Kcal/100 g, followed by TCC1 (10% of KPP) with a value of 351.35 Kcal/100 g (Table 5). The least value of 345.44 Kcal/100 g was recorded for the energy content of the KP cupcake in TCC4 (8 minutes of blanching).

The increased blanched KPP resulted in increased fibre contents and materials, weakening the gluten network. The fibre disorganised the starch-gluten matrix and decreased the gas retention capacity (Aydogdu *et al*., 2018). It affects the overall acceptability of the cupcakes. Therefore, CCT2 (20% blanched KPP) may be used for cupcake formulation.

CONCLUSION

The study results evinced that the blanching of KPP for 8 minutes enhances the organoleptic attributes of KPs. This cupcake obtained after blanching for 8 minutes (T4) can be regarded as the best KP cupcake. The cupcakes prepared by incorporating blanched KKP (20%) will help enhance the fibre content in the processed products. The citrus peel contains different antioxidant properties; therefore, the products prepared using blanched KPP would also assist in antioxidant-rich product formulation. However, more research works must be conducted on the loss of antioxidant contents while blanching with respect to time duration.

ACKNOWLEDGEMENT

The authors acknowledge the support and laboratory facilities provided by the ITM University Gwalior, Madhya Pradesh, India.

Funding sources

The authors received no financial support for the research, authorship and/or publication of this article.

Credit authorship contribution statement

Kashagoni Kalyani, Dashrath Bhati and Harendra: Conceptualisation and methodology; Dashrath Bhati: Supervision, writing, reviewing and data analysis; Deepak Maurya and Dinesh Baboo Tyagi: Validation and formal analysis.

Conflict of interest: None.

REFERENCES

Ahmad, M.M., Salim-ur-Rehman Z, Iqbal, F.M.A and Sultan J.I., (2006). Genetic variability to essential oil composition in four citrus species. Pak. J. Bot. 38(2): 319-324.

Akyildiz, A. and Aðçam E., (2014). Citrus Juices Technology. In: Food Processing: Strategies for Quality Assessment), [(Eds) Malik A., Erginkaya Z., Ahmad S. and Erten H.] Springer, New York, NY, pp. 36-103.

AOAC, (2005). Official Methods of Analysis. 18th edn. Association of Official Analytical Chemists, Arlington, TX.

Aydogdu, A., Sumnu, G. and Sahin S. (2018). Effects of addition of different fibers on rheological characteristics of cake batter and quality of cakes. J. Food Sci. Technol. 55: 667-677.

Bejar, A.K., Kechaou N. and Mihoubi N.B. (2011). Effect of microwave treatment on physical and functional properties of orange (*Citrus sinensis*) peel and leaves. J. Food Process Technol. 2(2): 109. doi:10.4172/2157-7110.1000109.

Ben Zid, M., Dhuique-Mayer, C. and Bellagha, S. (2015). Effects of blanching on flavanones and microstructure of *Citrus aurantium* peels. Food Bioprocess Technol. 8: 2246-2255.

Berhow, M., Tisserat, B., Kanes, K. and Vandercook, C. (1998). Survey of Phenolic Compounds Produced in Citrus, Technical Bulletin No. 1856, US Department of Agriculture, Peoria, IL.

Fellows P.J. (2019). Blanching, Chapter 11. In: Food Processing Technology (Third Edition), [Fellows, P.J. (Ed.)], Woodhead Publishing, Sawston, pp. 369-380, https://doi.org/10.1533/9781845696344.3.369.

Ferreira, L., Afonso, C., Vila Real, H., Alfaia, A. and Rebeiro, M.H.L. (2008). Evaluation of the effect of high pressure on naringin hydrolysis in grapefruit juice with naringinase immobilised in calcium alginate beads. Food Technol. Biotechnol. 46: 146-150. https://hrcak.srce.hr/24398.

Gomez, K.A and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, NY, pp. 680.

Gorinstein S., Huang, D., Leontowicz, H., Leontowicz, M., Yamamoto, K., Soliva-Fortuny, R., Martin-Belloso, O, Martinez Ayala A.L. and Trakhtenberg, S. (2006). Determination of naringin and hesperidinin citrus fruit by high-performance liquid chromatography: The antioxidant potential of citrus fruit. Acta Chromatogr. 17: 108-224.

Larmond, E. (1970). Methods for Sensory Evaluation of Foods, Food Research Institute, Central Experimental Farm, Ottawa.

Mahaot, N., Sharma, K., Nabybaccus, F. and Cho H.M. (2016). Citrus waste reuse for health benefits and pharma/nutraceutical application. J. Med Res. 3: 20-32.

Mahawar, M.K., Jalgaonkar, K., Bibwe, B., Bhushan, B., Meena, V.S. and Sonka, R.K. (2019). Post-harvest processing and valorisation of kinnow mandarin (*Citrus reticulate* L.). J. Food Sci Technol. 57: 799-815.

Mann, S. and Aggarwal, M.P. (2013). Development of phytochemical rich ice cream incorporating kinnow peel. Global J. Sci Front Res. 3: 1-3.

Manthey, J.A. and Grohmann, K. (2001). Phenols in citrus peel byproducts. Concentrations of hydroxycinnamates and polymethoxylated flavones in citrus peel molasses. J. Agric Food Chem. 49: 3268-3273.

Mateos-Aparicio, I., Mateos-Peinado, C. and Ruperez, P. (2010). High hydrostatic pressure improves the functionality of dietary fiber in okara byproduct from soybean. Innovative Food Sci. and Emerging Techn. 11: 445-450.

Mudambi, S.R. and Rao, S. (1989). Food Science. Wiley Eastern Ltd., New Delhi.

NHB. (2022), 2021-22 Indian Production of Mandarin (M.Orang, Kinnow, Orange). 1st Adv. Estimate. agriexchange.apeda.gov.in. (accessed 8 November 2022).

Ojha, P. and Thapa, S. (2017). Quality evaluation of biscuit incorporated with mandarin peel powder. Sci Chemistry Chem Eng Biotechnol Food Ind. 18: 19-30.

Okaka, J.C. and Potter, N.N. (1979). Physico-chemical and functional properties of cowpea powders processed to reduce beany flavor. J. Food Sci. 44: 1235-1240.

Puupponen-Pimia, R., Hakkinen, ST, Aarni, M, Suortti, T, Lampi, A.M., Eurola, M., Piironen, V., Nuutila, A.M. and Oksman-Caldentey, K.M. (2003). Blanching and long-term freezing affect various bioactive compounds of vegetables in different ways. J. Sci. Food Agric. 83(14): 1389-1402.

Ranganna, S. (2012). Handbook of Analysis and Quality Control for Fruits and Vegetable Products. 7th Edition, Tata McGraw Hill Book Co., New Delhi, pp. 594-625.

Safdar, M.N., Kausar, T., Jabbar, S., Mumtaz, A. Ahad, K. and Saddozai, A.A. (2017). Extraction and quantification of polyphenols from kinnow (*Citrus reticulate* L.) peel using ultrasound and maceration techniques. J. Food Drug Anal. 25: 488-500.

Samson, J.A. (1986). Tropical fruit. Second edition. Longman Scientific and Technical. Singapore.

Sidhu, N., Arora, M. and Alam, M.S. (2016). Biochemical, microbial stability and sensory evaluation of osmotically dehydrated kinnow peel candy and peel powder. Int. J. Sci. Res. 5(9): 1428-1436.

Zhang, M., Bai, X. and Zhang Z.S. (2011). Extrusion process improves the functionality of soluble dietary fiber in oat bran. J. Cereal Sci. 54: 98-103.