

## RESEARCH NOTES

# Physio-chemical and Functional Quality Evaluation of Mandarin Peel Powder

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### ABSTRACT

The research focused to evaluate physical, chemical, and sensory properties of raw, blanched, and 2, 4, and 6% osmotically salt treated Mandarin (*Citrus reticulata*) peel powder. The yields of Mandarin Peel Powder (MPP) were found in the range of 29.1 to 30.4% (db) for different treatments, which were not significantly different. The bulk density and solubility were found in the range of 1,267-1,308 (kg m<sup>-3</sup>) and 17.4-28.4%, respectively, the highest value was for blanched peel powder. Blanched peel powder contained highest carotenoids (3245 µg g<sup>-1</sup>) and polyphenols (102.72 mg GAE g<sup>-1</sup>) whereas 6% salt treated peel powder contained the highest Tannin (0.19 mg of GA 100 g<sup>-1</sup> FW), ascorbic acid (13.62 mg 100 g<sup>-1</sup>), and antioxidant activity (66.1% DPPH inhibition) among the other treatments. Blanched peel powder was found to be the best in terms of sensory evaluation.

**Keywords:** Blanched peel powder, Carotenoids, Sensory evaluation, Tannin.

### INTRODUCTION

Mandarin fruits are mainly used by juice processing industries while the peels are generally wasted. Fifty percent of the total weight will be lost as pomace, peel, and seed after extraction of juice (FAO, 2010). Disposal of by-products not only leads to loss of potential revenues but also leads to the added and increasing cost of disposal of these products (Jayathilakan *et al.*, 2012). Mandarin peels, which comprise the dominant residue, exhibits potent antioxidant and anti-inflammatory activities (Murakami *et al.*, 2000) and is considered a potential source of functional components (Schieber *et al.*, 2001). Additionally, mandarin peel is a good source of bioactive compounds such as polyphenols,

carotenoids, vitamins, enzymes and dietary fibers (Ajila *et al.*, 2007).

Mandarin peel is processed to obtain valuable fractions for applications in food, drugs, and cosmetics (Ho and Lin, 2008). Citrus peel is the main waste fraction of citrus fruits, which is also widely studied because it contains numerous biologically active compounds. A study has found that mandarin peel in addition to a high proportion of soluble dietary fiber, which is similar to other citrus fruits, also has a substantial amount of pectin and polyphenols (Larrauri *et al.*, 1996).

By-products such as mandarin peel can be a source of potentially valuable bioactive compounds and utilization of mandarin peel can yield both economic and environmental benefits. Despite these valuable components, the peels are being discarded due to their

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bitter taste. Thus, peels can be treated to reduce their bitterness. Chromatographic analysis, carried out on an osmotic solution after the 24 hours of treatment, attested the presence of limonene, a triterpene compound responsible for the bitterness of the peel and located mainly in the albedo. Comparing the concentration of limonene found in osmotic solution and in the raw peel indicated that the peels lost, on average, 50% of the initial content of limonene by the 12 hours pre-treatment (Cortellino *et al.*, 2011).

The purpose of this study was to evaluate physical, chemical, and sensory properties of mandarin peel powder obtained from different treatments.

## MATERIALS AND METHODS

Mandarins were collected from a fruits and vegetable store in *Bulkhu*, Kathmandu, Nepal.

Preparation of Mandarin Peel Powder (MPP)

Mandarin Peel Powder (MPP) was prepared as shown in Figure 1. MPP yield was calculated by using the initial peel

amount and treated, dried, and sieved amount as per Bilgicli, (2009).

## Chemical Analysis

All raw materials and processed products were analyzed in the laboratory of National College of Food Science and Technology (NCFST), Kathmandu, Nepal. Moisture content, crude protein, crude fiber, total carbohydrate, tannin content and ascorbic acid were determined according to AOAC (2005). Crude fat, ash content, and total carotenoids were determined as described by Ranganna (2005).

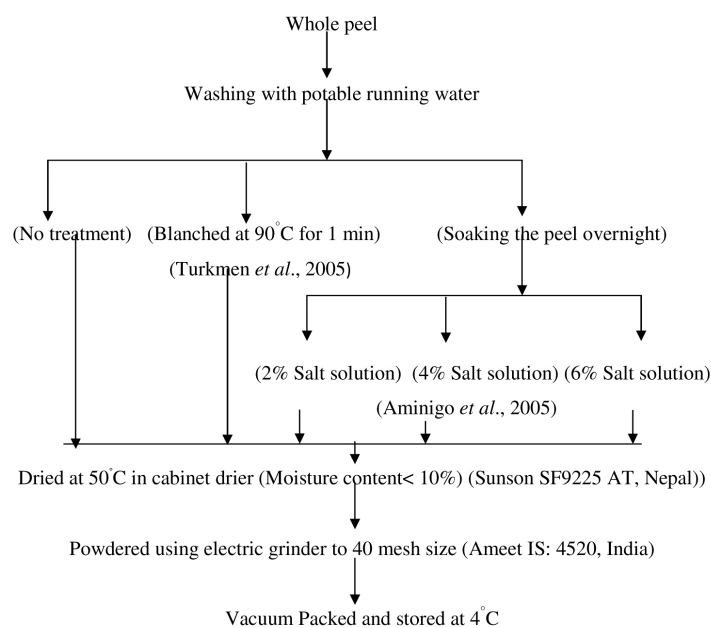
## Analysis of Physical Properties

### Bulk Density (BD)

The *BD* was determined according to the method described by Kanpairo *et al.* (2012).

### Solubility

The method of Onuegbu *et al.* (2013) was adopted for the determination of solubility.



**Figure 1.** Flowchart of mandarin peel powder preparation

### Total Polyphenol Content (TPC)

TPC was determined using a modified Folin-Ciocalteu Colorimetric method (Huang *et al.*, 2012) and the results were expressed as milligrams of Gallic acid equivalents per 100 g fresh weight (mg GAE 100 g<sup>-1</sup> FW).

### Antioxidant Activity

The antioxidant activity was determined by the method described by Nuengchamng *et al.* (2009).

### Sensory Evaluation

Sensory evaluation was performed by 9 point hedonic scoring test (9= Like extremely, 1= Dislike extremely) as per Ranganna (2005) for color, flavor and overall acceptability of the peel powder. The evaluation was carried out by 15 semi trained panelists comprising of graduate

students, teachers, and students of NCFST, Nepal.

### Data Analysis

All the data obtained in this experiment were analyzed by statistical program Genstat release 7.22, VSN International Ltd. Sample means were compared by LSD method at 95% level of significance.

## RESULTS AND DISCUSSION

### Yield of MPP

Yield of MPP are shown in Table 1. The results show that yield of different treatments ranged within 29.1-30.91 and were not significantly different on dry basis.

### Physical Properties of MPP

Physical properties of raw and treated MPP are presented in Table 2.

**Table 1.** Yield % of raw and treated peels. <sup>a</sup>

Mandarin peel	Wt. Mandarin peel (g)	Peel powder amount (g)	Yield %	Moisture of peel powder (%)	Moisture of raw peel (%)
Raw	2000±00	192.73±5.45	30.14±1.74 <sup>a</sup>	9.3 ±0.45	71±0.4
Blanched	2000±00	192.79±3.16	30.91±1.44 <sup>a</sup>	7.01 ± 0.55	71±0.4
2% salt treated	2000±00	182.63±4.16	29.1±1.13 <sup>a</sup>	8.21 ± 0.27	71±0.4
4% salt treated	2000±00	186.89±3.75	29.5±0.99 <sup>a</sup>	8.45 ± 0.29	71±0.4
6% salt treated	2000±00	193.61±3.70	30.41±1.08 <sup>a</sup>	8.90 ± 0.88	71±0.4

<sup>a</sup> All data are the mean ± Standard Deviation of triplicates, Values (Yield%) with same superscripts in the same row are not significantly different (p>0.05) statistically, Yield% is expressed in dry basis whereas Moistures are expressed in wet basis.

**Table 2.** Physical properties of raw and treated MPP. <sup>a</sup>

Sample	Bulk Density (Kg/m <sup>3</sup> )	Solubility (%)
Raw peel powder	1305±3 <sup>a</sup>	28±2.4 <sup>a</sup>
Blanched peel powder	1308±3 <sup>a</sup>	28.4±1.76 <sup>a</sup>
2% salt treated peel powder	1267±3 <sup>c</sup>	17.4±1.13 <sup>b</sup>
4% salt treated peel powder	1282±3 <sup>b</sup>	17.9±1.06 <sup>b</sup>
6% salt treated peel powder	1306±3 <sup>a</sup>	19.2±1.32 <sup>b</sup>

<sup>a</sup> All data are the mean ± Standard Deviation of triplicates, Values with same superscripts in the same row are not significantly different (p>0.05) statistically.



Bulk density and solubility were found to be  $1,308 \pm 3 \text{ kg m}^{-3}$  and 28.4%, respectively, for blanched MPP, which were highest among other treatment. Tagodoe and Nip (1994) had found that bulk density increased as a result of heat treatment of flour prior to drying. Higher bulk density offers an advantage during transportation and distribution (Onuegbu *et al.*, 2013). The high solubility of powder indicated potential applications in formulated food systems by providing an attractive appearance and a smooth mouth feel to the product (Kanpairo *et al.*, 2012). Solubility is the most reliable criterion to evaluate the behavior of powder in aqueous solution (Caparino, 2012).

### Chemical Composition of MPP

The chemical composition of raw and treated mandarin peel powders is shown in Table 3.

There were no significant differences in crude fiber and carbohydrate content among

various treatments, but crude protein content and crude fat content were found to be low in blanched MPP (3.82 and 1.93%, respectively) as compared to raw MPP (4.39 and 3.36%, respectively). Also, the result shows that carotenoid content was significantly high ( $P > 0.05$ ) in blanched MPP ( $2,143 \mu\text{g g}^{-1}$ ), whereas tannin and ascorbic acid contents (0.16% and  $10.92 \text{ mg g}^{-1}$ , respectively) were found to be low.

Blanching pre-treatment decreases mineral content probably due to losing of small molecules such as minerals, vitamins, and sugar to blanching water resulting in relatively increase in other dry matter (Wennberg *et al.*, 2004; Nilnakara *et al.*, 2009). The decreased in protein content by the various treatments could be attributed to the fact that some of the proteins were leached off by water during soaking and blanching (Oboh, 2005). Fat content was only affected much by blanching and showed significant decreased ( $P \leq 0.05$ ). Blanching before dehydration results in higher retention of  $\beta$ -carotene (Negi and

**Table 3.** Chemical composition of raw and treated MPP. <sup>a</sup>

Parameters <sup>b</sup>	Raw	Blanched	2% salt treated	4% salt treated	6% salt treated
Crude fiber	$7.21 \pm 0.03^a$	$7.27 \pm 0.25^a$	$7.12 \pm 0.04^a$	$7.15 \pm 0.02^a$	$7.17 \pm 0.02^a$
Crude protein	$4.39 \pm 0.02^a$	$3.82 \pm 0.02^b$	$3.91 \pm 0.02^b$	$4.13 \pm 0.02^{ab}$	$4.2 \pm 0.03^{ab}$
Crude fat	$3.36 \pm 0.05^a$	$1.93 \pm 0.03^c$	$2.84 \pm 0.03^b$	$3.04 \pm 0.02^{ab}$	$3.25 \pm 0.02^{ab}$
Ash content	$4.92 \pm 0.03^a$	$4.17 \pm 0.02^b$	$4.61 \pm 0.03^{ab}$	$4.73 \pm 0.06^{ab}$	$4.84 \pm 0.03^a$
Total carbohydrate	$80.1 \pm 2.87^a$	$82.78 \pm 2.86^a$	$81.52 \pm 3.22^a$	$80.99 \pm 2.45^a$	$80.56 \pm 1.7^a$
Carotenoids ( $\mu\text{g/g}$ )	$2143 \pm 25.24^b$	$3245 \pm 20.66^a$	$1943 \pm 28.58^d$	$1989 \pm 27.22^c$	$2011 \pm 22.61^c$
Tannin (mg of GA/100g)	$0.2 \pm 0.02^a$	$0.16 \pm 0.01^b$	$0.17 \pm 0.01^{bc}$	$0.18 \pm 0.01^{bc}$	$0.19 \pm 0.01^c$
Ascorbic Acid (mg/100g)	$28 \pm 1.94^a$	$10.92 \pm 2.04^b$	$12.14 \pm 2.08^b$	$12.85 \pm 1.92^b$	$13.62 \pm 2.08^b$

<sup>a</sup> All data are the mean  $\pm$  Standard Deviation of triplicates, Values with same superscripts in the same row are not significantly different ( $p > 0.05$ ) statistically, <sup>b</sup> Crude Fiber, Crude Protein, Crude Fat, Ash Content and Total Carbohydrate are expressed in dry basis.

**Table 5.** Analysis of functional properties of raw and treated MPP. <sup>a</sup>

Parameters	Raw	Blanched	2% salt treated	4% salt treated	6% salt treated
Polyphenol (mg GAE/g)	$125.85 \pm 6.78^a$	$102.72 \pm 8.41^b$	$84.2 \pm 6.53^c$	$87.84 \pm 6.09^c$	$92.37 \pm 5.43^{bc}$
Antioxidant (% DPPH inhibition)	$72 \pm 3.12^a$	$65 \pm 3.66^b$	$64.1 \pm 3.03^b$	$64.9 \pm 3.57^b$	$66.1 \pm 3.53^{ab}$

<sup>a</sup> All data are the mean  $\pm$  Standard Deviation of triplicates, Values with same superscripts in the same row are not significantly different ( $p \leq 0.05$ ) statistically.

Roy, 2001). Leaching of soluble solids during blanching is the major factor, responsible for apparent increase in carotenoids (Desobry *et al.*, 1998). Blanching before dehydration also results in higher retention of  $\beta$ -carotene (Negi and Roy, 2001). Mayer and Spiess (2003) reported high availability and stability of carotene is achieved in Kintoki carrot products after blanching at high temperature (90°C). The amount of water used during blanching affects the amount of ascorbic acid lost due to leaching of water soluble compound into blanched water (Lin and Brewer, 2005). Also, the loss in ascorbic acid during blanching could be attributed to the fact that vitamin C is very soluble in water and not stable at high temperatures (Dewanto *et al.*, 2002). According to Sanjinez-Argandona *et al.* (2005), the reduction of ascorbic acid content during the osmotic dehydration of pepper could be related to the partial degradation due to oxygen, light, and temperature exposure. Pant *et al.* (2004) reported 17.5 to 20.4% loss of tannin during blanching.

### Analysis of Functional Properties

The result is summarized in Table 4. Polyphenol content in blanched sample was found to be the highest 102.72 mg GAE g<sup>-1</sup> as compared to other pre-treatments, but lower than the raw one i.e. 125.85 mg GAE g<sup>-1</sup>. Antioxidant content decreased by all the treatments but were not significantly different at 5% level of significance.

Polyphenol content in ripe peel was higher compared to that of raw peel (Ueda *et al.*, 2000) and highly concentrated in peels and seeds than fleshy parts of fruits (Nogata *et al.*, 2006). Mandarin peel had the higher total phenol content as compared to orange peels (Magda *et al.*, 2008). Ghasemi *et al.* (2009) reported the total phenolic contents of *Citrus reticulata* varieties peel in the range of 104.2- 172.1 mg GAE g<sup>-1</sup>. The treatment of blanching (100°C for 90 seconds) was found more effective to

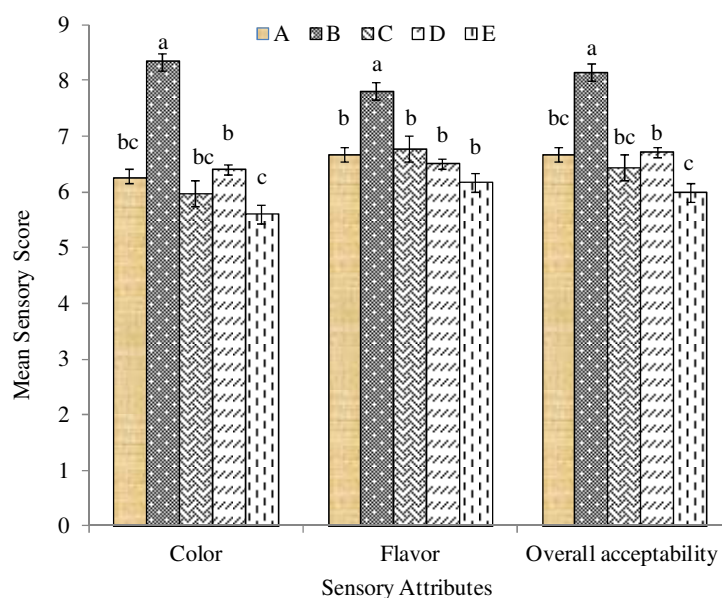
preserve the losses of polyphenols (Gorinstein *et al.*, 2009). Blanching carrot at 90°C for 1 minute retained 80% of its initial total phenolic content (Ismail *et al.*, 2004; Turkmen *et al.*, 2005). Components such as phenolic compounds and vitamin C are responsible for its powerful antioxidant capacity (Phisut *et al.*, 2013).

### Sensory Analysis of Raw and Pre-treated MPP

The sensory score of MPP is shown in Figure 2. MPP were evaluated on the basis of color, flavor and overall acceptance. The mean sensory score for color, flavor, and overall acceptability of blanched peel powder were 8.33±0.62, 7.80±0.94, and 8.13±0.64, respectively, which were significantly greater at 5% level of significance than the other treatments and the raw sample. The highest score for blanched peel powder may be due to more yellowish color resulting from the natural pigment present in the peels (Magda *et al.*, 2008). Greater reduction of tannin in blanched mandarin peel powder may result in lower astringent sensation among other treated samples (Oluremi *et al.*, 2007). This is in accordance with the study where the blanched MPP has the lowest tannin content and may have resulted in higher sensory score.

### CONCLUSIONS

Blanched mandarin peel powder was in terms of carotenoid content and functional component. Similarly, blanched MPP was also better in terms of sensory properties. The solubility of blanched MPP was also greater than other treatments. This offers an advantage of incorporation of blanched MPP in other food formulation to increase their functional property.



**Figure 2.** Selection of best MPP obtained from different treatments on the basis of sensory analysis. Vertical error bars represent  $\pm$  Standard Deviation of scores given by 15 panellists. Same alphabet at the top of the bars indicated not significantly different ( $p \leq 0.05$ ) statistically. A= raw MPP, B= blanched MPP, C, D and E = 2%, 4% and 6% osmotically salt treated MPP respectively.

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## ارزیابی فیزیو-شیمیایی و عملکرد کیفیتی پودر پوست نارنگی

پ. اوجها، ت. بهادر کارکی، و ر. سینتولا

### چکیده

هدف این پژوهش ارزیابی فیزیکی، شیمیایی و خواص حسی پودر پوست نارنگی (*Citrus reticulata*) طبیعی، سپید شده (blanched) و تیمار شده با ۰.۲٪، ۰.۴٪، و ۰.۶٪ نمک بود. عملکردهای پودر پوست نارنگی (MPP) تیمارهای مختلف در محدوده ۰.۲۹/۱٪ و ۰.۳۰/۴٪ بر مبنای وزن خشک (d.b.) بود و تفاوت معنی داری با هم نداشتند. جرم مخصوص در تیمارهای مختلف در دامنه ۱۳۰۸-۱۲۶۷ کیلوگرم در متر مکعب و حلالیت در محدوده ۰.۲۸/۴-۰.۱۷/۴٪ به دست آمد و بیشترین مقدار در تیمار پودر پوست سپید شده بود. پودر اخیر بیشترین کاروتینوئید (۳۲۴۵ μg/g) و پلی فنل (۱۰۲.۷۲ mg GAE/g) را داشت در حالی که در میان همه تیمارها، تیمار ۰.۶٪ نمک حاوی بیشترین مقدار تانین (۰.۱۹ mg of GA/100 g FW)، اسکریبیک اسید (۱۳.۶۲ mg/100 g) و فعالیت آنتی اکسیدانی (66.1% DPPH inhibition) بود. نتیجه این که از نظر ارزیابی خواص حسی، پودر پوست سپید شده بهترین بود.