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Comparative study between the effects of mango and orange peels preparations on the total dietary fiber

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Abstract: *The objective of this study was to investigate the influence of different preparation methods of mango and orange peels on the chemical compositions and properties of dietary fiber concentrate used as a raw material for functional foods.*

Mango and orange samples were purchased from the local market. Four different preparation methods of mango and orange peels of dry milling, wet milling, wet milling and cold water washing, and wet milling and hot water washing were investigated on their effects on the chemical composition and properties of the mango and orange peels dietary fiber concentrate.

Chemical constituents, dietary fiber content, water holding capacity, oil holding capacity, water activity and color were determined for the tested mango and orange peels.

The proximate composition of fresh mango peel was 59.9% moisture, 4.27% protein, 3.21% fat, 1.87% ash and 1.074% starch. The total dietary fiber content ranged from 3.54% to 73.04% in mango peels. On the other hand, the proximate composition of fresh orange peel was 72.5% moisture, 2.46% protein, 1.41% fat, 0.597% ash and 0.263% starch. Washing after wet milling could enhance the concentration of total dietary fiber by improving the removal of protein and fat. Washing with hot water after wet milling process caused a higher loss of soluble fiber fraction. On contrary, was lower water holding capacity and oil holding capacity of the obtained dietary fiber concentrate when compared to washing with cold water. The dry milling process of the dietary fiber concentrate was significant higher fat, protein, and starch content than the wet milling process. On the other hand, the dry milling process of the dietary fiber concentrate was lower water holding capacity and oil holding capacity in the mango peel. Wet milling and cold water washing of the dietary fiber concentrate the highest concentration of total and soluble dietary fiber, water holding capacity and oil holding capacity in the orange peel.

Keywords: *mango peel, orange peel, dietary fiber, wet milling, dry milling, functional properties*

I. Introduction

Functional foods are similar in appearance to conventional foods; the former being consumed as part of the normal diet. In contrast to conventional foods, functional foods, however, have demonstrated physiological benefits and can reduce the risk of chronic disease beyond basic nutritional functions, including maintenance of gut health [34]. When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food". Thus, functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, *etc*., needed for its healthy survival; **FAO (2010)**

The functionality and bioavailability of bioactive compounds are strongly affected and determined by their chemical properties, in terms of solubilisation and depolymerisation; **Lesmes and McClements (2009).** Also further processing of the food material may dramatically affect the bioavailability of nutrients and phytochemicals, as do the environmental conditions during its passage through the gastrointestinal tract. The influence of heat and mass transfer in food processing affects food microstructures. The complexity of food matrix determines both food texture and also the release of functional components. It has been suggested that quantitative structure function relationships can help the rational design and efficient production of such functional food system; **Lattanzio *et al.*, (2009).** However, currently the knowledge base on bioactive ingredients and food structure is very limited. Future studies should provide further data which can aid in the understanding of bioavailability of specific compounds and hence an improved description of food processes; **Lesmes and McClements (2009),** as not only the bioavailability, of selected micronutrients and phytochemicals, but also the general ingredient stability is affected by the food matrix.

In a rapidly changing world, with altered food habits and stressful life styles, it is more and more recognized that a healthy digestive system is essential for the overall quality of life **Burton (2000).** Dietary fiber has shown beneficial effects in the prevention of several diseases, such as cardiovascular diseases, diverticulosis, constipation, irritable colon, colon cancer, and diabetes; **Rodriguez *et al.*, (2006).** The fruit fiber has a better quality than other fiber sources due to its high total and soluble fiber content, water and oil holding capacities, and colonic fermentability, as well as a lower phytic acid and caloric value content; **Figuerola *et al.*,**

(2005). A high dietary fiber content of orange (about 50 g/ 100 g) is indicative of a good source of dietary fiber; **Happi Emaga *et al.*, (2007).**

The solid wastes generated by fruit processing industries can serve as potential raw materials for the production of secondary metabolites of industrial significance by microorganisms. Peels are the major by-products obtained during the processing of various fruits and these were shown to be a good source of various bioactive compounds which posses various beneficial effects. But, significant quantities of fruit peels (20- 30% for orange and 30 -50% for mango) are discarded as waste by the processing industries which cause a real environmental problems; **Zhang *et al.*, (2005)**. Theses fruit processing wastes can be used as potential feedstock for bioethanol production and this could also be an attractive alternate for disposal of the polluting residues; **Wyman (2001)**. Some few research articles deal with different practical applications of these fruit wastes (orange and mango), e.g., production of microbial enzymes for industrial uses production of alcohol , production of wine, vinegar, production of biogas and food for livestock; **Essien *et al.*, (2005).**

Fruits are important natural sources of antioxidants and dietary fiber. For the purpose of transportation, food product development, and extension of shelf life, they are also processed into packaged juice drinks, food ingredients, and other food products. During processing fruit peels in most cases are discarded and treated as wastes due to their lack of commercial application. Fruit peels that become wastes consequently add to the current severe pollution problem; **Emaga *et al.*, (2008).** Previous studies, however, showed that, in general, fruit peels contain higher concentrations of dietary fiber [1] and antioxidant compounds than the flesh of the fruit. It is therefore possible to utilize fruit peels as dietary fiber and antioxidant food additive to produce value-added food products for human consumption and they may play a role in the prevention for risk of chronic diseases e.g., diabetes mellitus, cardiovascular diseases and cancer; **Kondo *et al.*, (2007).** The production of fruit peel ingredients is very economical because it can be produced in a small or large scale. The raw material is obtained from the by-product (waste) of the processed food industry and the process and equipment used in its production is simple and cheap. Fruit peel powder as a good source of dietary fiber and antioxidant can be added to bakery products, recipes and other food products for good health; **Priscilla Alice and Trinidad (2013).** The objective of this study was to investigate the influence of different preparation methods of mango and orange peels on the chemical compositions and properties of dietary fiber concentrate used as a raw material for functional foods.

II. Materials And Methods

Materials:

Source of samples:

Mango and orange samples were purchased from the local market.

The chemicals:

The commercial α-amylase Termamyl 300L Type LS, amyloglucosidase (AMG E) and neutral protease from *B.* subtilis (Neutrase®) were obtained from El-Gomhoria Company for chemicals, Egypt.

Preparation of peel powders:

The peels were removed from the flesh with a stainless steel knife and the peels were submitted to the following processes; **Adejuyitan *et al.*, (2008).**

1- Dry milling (DM): the peel samples were dried at 50°C in a hot air oven for 12 hrs and ground to obtain the particle size of less than 1.0 mm.
2- Wet milling (WM): the peels to water ratio of 1: 5 were blended in a commercial blender and screened through a 1 mm sieve.
3- Wet milling and cold water washing (WM-C): after wet milling the peels prepared by washed with cold water at 2°C in the same amount as used in the wet milling process for 5 min.
4- Wet milling and hot water washing (WM-H): after wet milling the peels prepared by washed with hot water at 95°C in the same amount as used in the wet milling process for 5 min.

Extraction of dietary fiber:

Dietary fiber from peels was extracted using the method of; **Yoshimoto *et al.* (2005).** The peels powder samples were defatted for 12 hrs using hexane as a solvent (5 ml/g sample). The residue was dried at 50°C in a hot air oven to assure complete removal of the solvent. The defatted peel powder was mixed with water (1: 20 w/v ratio). The pH was adjusted to 5.8 by adding 1 N HCl solution. An alpha-amylase was added (0.1 ml/ g sample). The sample was incubated at 95°C for 30 min. after cooling down to 60°C, the pH was adjusted to 7.5 by adding 1 N NaOH. Neutrase® was then added (10 mg/ g sample) and incubated for 30 min at 60°C. After that, the pH was adjusted to 4-4.5 by using 1 N HCl solution. An amyloglucosidase solution was added (0.1 mg/ g sample) at 60°C for 30 min. Finally, the mixture was filtered through Whatman No.4 filter paper and dried in the hot air oven at 50°C for 12 hrs. The dried samples were then powdered in mill using a 1 mm sieve.

Methods:

Chemical Analysis:

Chemical composition: the peels of mango and orange samples were analyzed for moisture, ash, protein, fat and starch contents using the methods described by; **AACC (2000).** Total dietary fiber (TDF), insoluble dietary fiber (IDF) and soluble dietary fiber (SDF) contents were determined by enzymatic and gravimetric method of; **AOAC (2005).**

Functional properties: the water activity (AW) of the peels of mango and orange samples was measured using Hygroscopic Rotronic as described by; **Frank (1983).** To evaluate the water holding capacity (WHC) and oil holding capacity (OHC) of the dietary fibers, the amount of water and oil released after centrifugation was quantified according to the modification of centrifugation method of; **Larrauri *et al.* (1996).** The dietary fiber samples of 0.5 g were stirred in 10 ml of water or soybean oil and left at 30°C for 20 min. After that, the mixture was centrifuged at 3,000 ×*g* for 20 min and the residue was weighed and WHC and OHC calculated as g water or oil per g of dry sample respectively.

Indigestible fraction: total indigestible fractions (TIF), soluble indigestible fractions (SIF) and insoluble indigestible fractions (IIF) were assessed using the sequential pepsin/amylase hydrolysis protocol of;

Saura-Calixto *et al.* (2000).

Total dietary fiber digestibility: The rapidly digestible fiber (RDF), slowly digestible fiber (SDF) and resistant fiber (RF) fractions were determined with the procedure proposed by; **Englyst *et al.*, (1992).**

Color measurements: of the mango and orange peels dietary fiber were carried out instrumentally using a color meter (Chroma, CR200, Japan) was determined according to the tristimulus color system described by; **Francis (1983).** The CIE chromaticity coordinates (L*, a* and b*) were measured. The L* values gives a measure of the lightness of the product color from 100 for perfect white to zero for black. The redness/ greenness and yellowness/ blueness are denoted by the a* and b* values, respectively. The chroma (C) represents color saturation or purity was calculated from $C = (a^2+b^2)^{1/2}$ and total color intensity $(a^2+b^2+L^2)^{1/2}$.

Statistical analysis

Statistical analysis was performed using computer program; **SPSS (2010).** One-way analysis of variance (ANOVA), low significant differences (LSD) and Duncan were used, the difference was considered significant at p-value < 0.05 according to; **Zar (1984**).

III. Results And Discussion

Chemical composition:

The present data Table (1) indicated that the moistures were higher in orange peel than the mango peel (72.5 and 59.9 g/100g samples). On the other hand, the total protein of the mango peel was higher (4.27g/100g) and lowest in orange peel (2.46 g/100g).

The present data indicated the nutrient values of mango peel were 3.21 g/100g, 1.87 g/100g and 1.074 g/100g of fats, ash, and starch, respectively. On contrary, the values of orange peel were 1.41 g/100g, 0.59 g/100g and 0.263 g/100g of fats, ash, and starch, respectively. Several authors have reported that the degradation of starch to free sugars during the ripening process due to combined action of several enzymes; **Emaga *et al.*, (2007).** A considerable decline in starch content from 20-23 to less than 1% and increase in soluble sugar from less than 1% to 20%was observed by; **Regina and Gloria (2005).** In fruit pulps during ripening and the degradation of starch reserve in fruit pulps appears to be relatively rapid where as in peels the conversion is rather gradual. **Emaga *et al.*, (2007)** have reported that even though starch is the main carbohydrate present in the mature green mango fruit, but as the fruit becomes over-ripe, only traces of starch can be detected.

Table (1): Chemical composition of fresh mango and orange peels

Chemical composition	Content (g/100 g dry matter)	
	Mango peels	Orange peels
Moistures	59.9±0.023	72.5±0.02
Protein	4.27±0.04	2.46±0.03
Fat	3.21±0.05	1.41±0.13
Ash	1.87±0.13	0.59±0.04
Starch	1.074±0.13	0.263±0.04

The results present in the Table (2) showed that the protein contents of the mango peel dietary fibers were in the range of 2.58-1.31 g/100 g. The protein and fat content of mango dietary fibers content prepared by dry milling tended to be higher (2.58 and 1.93 g/100g.) than that prepared by wet milling (2.29 and 1.45 g/100 g) although no significant difference was observed. The protein and fat contents in the mango dietary fibers content prepared by WM-C and WM-H were significantly lower than prepared by DM and WM. **Adejuyitan *et***

***al.*, (2008)** showed that the wet milling process was known to effectively separate protein-containing and non-protein-containing products by softening the plant tissue for milling, helping breakdown the protein, and also removing certain soluble constituents. The washing process allows for the soluble proteins to be removed from fibers, especially hot water washing, which additionally solubilized more proteins to water by denaturing and made more susceptible to enzyme.

The mango dietary fibers content prepared by dry milling process had significantly higher starch content (0.02 g/100 g) than the prepared by wet milling processes (0.01 g/100 g). In wet milling, the plant fibers were hydrated, resulting in a differential swelling and making the starch separation more effective; **Cabrales *et al.*, (2006).** The washing by hot water could produce the mango dietary fibers content with significantly lower starch content than the others.

The values of SDF and IDF in the mango dietary fibers content prepared by wet milling process had higher (19.97 and 57.48 g/100 g) than the prepared by dry milling processes (19.45 and 53.59 g/100 g). In addition to that the SDF by WM-H was higher than the other prepared (24.27 g/100g). There were found different IDF/ SDF ratios in mango dietary fibers content obtained using wet milling was higher 2.88:1 than the other prepared. **Larrauri, (1999) and Tatjana *et al.*, (2002)** showed that the hot water treatment caused the solubization of polysaccharides, resulting in the loss of the dietary fibre components, especially in the low molecular weight carbohydrates.

Table (2): Chemical compositions of the mango dietary fiber concentrates prepared by different methods.

Chemical composition	Preparation methods			
	DM	WM	WM-C	WM-H
Protein	2.58a±0.03	2.29a±0.04	1.46b±0.03	1.31b±0.03
Fat	1.93a±0.12	1.45b±0.43	1.16c±0.03	1.44b±0.67
Starch	0.02a±0.13	0.014b±0.21	0.014b±0.54	0.009c±0.23
TDF	73.04b±0.04	77.45a±0.04	78.35a±0.41	78.66a±0.04
SDF	19.45c±0.02	19.97c±0.23	21.54b±0.12	24.27a±0.62
IDF	53.59b±0.12	57.48a±0.14	56.81a±0.13	54.39b±0.04
IDF/SDF	2.76±0.13	2.88±0.13	2.64±0.12	2.24±0.03
IDF/TDF %	73.37±0.12	74.22±0.14	72.51±0.12	69.15±0.03
SDF/TDF %	26.62±0.45	25.78±0.14	27.49±0.56	30.85±0.41

(g/ 100 g dry matter of dietary fiber)

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

According to the data of Table (3) proved that the protein, fat and starch content of orange dietary fibers content prepared by dry milling tended to be higher (1.27, 1.06 and 0.09 g/100g.) than the other prepared. **Christie (2003)** indicated that the removal of some types of fats during water treatment. Pointed out that most complex lipids are slightly soluble in water and at least form micellar solutions, and lipids such as polyphosphoinositides, lysophospholipids, acyl-carnitines, and coenzyme A esters are especially soluble in water.

The protein and starch contents in the orange dietary fibers content prepared by WM-C and WM-H no significantly between prepared by WM-C (1.09 and 0.04g/100g) and WM-H (1 and 0.07 g/100g); it might be due to the fact that hot water washing caused the starch to gelatinize, involving the dissolution of hydrogen bonds among and within starch molecules to open the molecules up to hydration and enzymatic hydrolysis; **Hall (2003).**

The values of SDF and IDF were higher in the orange dietary fibers content prepared wet milling and hot water (WM-H) process (20.98 and 27.75g/100g) than the other prepared. Although no significant between TDF in the orange dietary fibers content prepared by WM, WM-C and WM-H. On the other hand, the values of IDF/SDF in the orange dietary fibers content prepared wet milling was higher (1.38:1) than the prepared wet milling and hot water (1.18:1). **Figuerola *et al.*, (2005)** showed that the ratio values from the orange peel DF are close to the well-balanced values (1.0-2.3: 1) in order to obtain the physiological effect associated with both the soluble and insoluble fractions. No significant effect of the preparation methods on the IDF/SDF ratio was observed.

Table (3): Chemical compositions of the orange dietary fiber concentrates prepared by different methods.

Chemical composition	Preparation methods			
	DM	WM	WM-C	WM-H
Protein	1.27a±0.34	1.22a±0.34	1.09a,b±0.012	1.00b±0.03
Fat	1.06a±0.87	0.84b±0.17	0.65c±0.31	1.02a±0.04
Starch	0.09a±0.34	0.02c±0.32	0.04b±0.03	0.07b±0.12
TDF	41.5b±0.14	46.36a±0.03	47.54a±0.04	48.73a±0.14

SDF	18.6c±0.12	19.45b±0.05	20.38b±0.31	20.98a±0.62
IDF	22.9c±0.03	26.91b±0.04	27.16a±0.27	27.75a±0.17
IDF/SDF	1.23±0.12	1.38±0.05	1.33±0.32	1.18±0.34
IDF/TDF %	55.18±0.34	58.05±0.12	57.13±0.03	56.95±0.14
SDF/TDF %	44.82±0.12	41.95±0.03	42.87±0.04	43.05±0.23

(**g/ 100 g dry matter of dietary fiber)**

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

The results present in the Table (4) showed that the WHC was higher in the mango and orange dietary fibers content prepared by WM-C (10.26 and 8.34 g water/g dry matter) than the prepared by DM was lower (6.08 and 5.76 g water/g dry matter). In the same pattern of OHC was higher was higher in the mango and orange dietary fibers content prepared by WM-C (5.87 and 10.30 g water/g dry matter) than the prepared by DM was lower (4.02 and 7.32 g water/g dry matter). On the other hand, the ratio WHC/ OHC was higher in the mango and orange dietary fibers content prepared by WM-H (1.92:1 and 0.87:1) than the prepared by DM was lower (1.51:1 and 0.79:1). This is in accordance with the results reported by; **Lario *et al.* (2004).** The lower values of WHC found in the orange prepared by DM in comparison with the other methods of preparation could be attributed to the lower content of soluble DF comprising some components in the plant tissue materials having the ability to hold water such as pectin, fructan and arabinoxylan; **Marin *et al.,* (2007)** and the higher content of protein and fat retarding hydration capacity of dietary fibers; **Raghvendra *et al.,* (2004) and Yamazaki *et al.,* (2005).** Moreover, dry milling affected its physical structure by breaking pores and therefore, the increasing fiber density and so reducing WHC**; Cadden (1987).**

The value of AW was higher in the mango and orange dietary fibers content prepared by DM (0.87 and 0.94) than the value of Aw was lower in the mango dietary fibers content prepared by WM-C (0.14) and in the orange dietary fibers content prepared by WM-H (0.17).These results are in agreement with those reported by; **Lario *et al.,* (2004).**

Table (4): Functional properties of the mango and orange dietary fiber concentrates prepared by different methods.

Functional properties	**Preparation methods**			
	DM	**WM**	**WM-C**	**WM-H**
		Mango peels		
WHC	6.08b±0.04	9.36a,b±0.02	10.26a±0.43	9.64a±0.03
OHC	4.02b±0.34	5.24a±0.02	5.87a±0.12	5.03b±0.03
WHC/ OHC	1.51±0.32	1.79±0.16	1.75±0.16	1.92±0.16
AW	0.87a±0.12	0.61a,b±0.62	0. 14c±0.12	0.35b±0.15
		Orange peels		
WHC	5.76c±0.14	7.48b±0.03	8.34a±0.02	7.93b±0.12
OHC	7.32c±0.12	9.37b±0.03	10.30a±0.17	9.16b±0.12
WHC/ OHC%	0.79±0.12	0.80±0.15	0.81±0.15	0.87±0.34
AW	0.94a±0.34	0.68a±0.23	0.35b±0.16	0.17c±0.45

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

The results in Table (5) indicated that the values of SIF and IIF in the mango and orange dietary fibers content prepared by WM-H (mango 28.29 and 63.73g/100g orange 23.72 and 45.68 g/100g) were higher than the other prepared. The ratio of IIF/SIF was almost similar pattern between the prepared samples in the mango and orange dietary fibers content this is due to no significant between prepared samples by WM, WM-C and WM-H of IIF in mango and orange dietary fibers content. TIF levels were higher in orange peels (11.06 g /100 g dry sample). Soluble indigestible fraction (SIF) in mango peels was higher (8.8 g/100 g dry sample). Similarly, the insoluble indigestible fraction (IIF) content of the mango was (27.4 g/100 g dry sample).Thus, indigestible fraction values corroborate that there is an increase in non-digestible components after incorporation in the mango, a fact that is considered of physiological importance in view of their potential as substrate for the colonic flora; **Saura-Calixto and Goñi (2004).**

Table (5): Indigestible fraction of the mango and orange dietary fiber concentrates prepared by different methods.

Fraction	Preparation methods			
	DM	**WM**	**WM-C**	**WM-H**
		Mango peels		
TIF	82.02b±0.03	90.28a±0.16	91.58a±0.34	92.02a±0.02
SIF	25.56c±0.02	27.69b±0.15	28.14a±0.52	28.29a±0.42
IIF	56.46b±0.21	62.59a±0.03	63.44a±0.12	63.73a±0.12
IIF/SIF	2.21±0.16	2.26±0.31	2.25±0.12	2.25±0.12
		Orange peels		
TIF	59.1b±0.34	66.03a,b±0.04	67.7a±0.17	69.4a±0.32
SIF	20.2c±0.34	22.57b±0.04	23.14a±0.21	23.72a±0.41
IIF	38.9b±0.06	43.46a,b±0.23	44.56a±0.72	45.68a±0.04
IIF/SIF	1.93±0.07	1.93±0.17	1.93±0.31	1.93±0.04

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

According to the data of Table (6) proved that the values of RDF and SDF no significant between prepared samples by WM-C and WM-H in the mango and orange dietary fibers content. On the other hand, the RF was lower in the mango dietary fibers content prepared by WM-C (4.71%) and the RF in the orange dietary fibers content prepared by WM was lower (2.75%). These results are in agreement with those reported by; **Maria *et al.*, (2011).**

Table (6): Total dietary fiber digestibility of the mango and orange dietary fiber concentrates prepared by different methods.

Fraction	Preparation methods			
	DM	**WM**	**WM-C**	**WM-H**
		Mango peels		
RDF	58.41b±0.03	61.99b±0.14	63.72a±0.21	63.98a±0.23
SDF	5.38c±0.21	8.81b±0.23	9.92a±0.23	9.96a±0.31
RF	9.24a±0.03	6.65b±0.04	4.71c±0.41	4.72c±0.04
TDF	73.04b±0.04	77.45a±0.04	78.35a±0.41	78.66a±0.04
		Orange peels		
RDF	32.75b±0.02	38.71a±0.16	38.67a±0.14	39.63a±0.03
SDF	3.51b±0.05	4.86b±0.15	6.02a±0.15	6.17a±0.04
RF	5.24a±0.13	2.75b±0.03	2.85b±0.04	2.93b±0.25
TDF	41.5b±0.14	46.36a±0.03	47.54a±0.04	48.73a±0.14

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

The results in Table (7) showed that the L* and b* were higher in the mango dietary fibers content prepared by WM-H (58.21 and 32.67). On the other hand, the L* and b* were lower in the orange dietary fibers content prepared by WM-H (58.21 and 32.67).

The a* was lower in the mango and orange dietary fibers content prepared by WM-H (2.44 and 3.36). In addition to, the total intensity was higher in the mango and orange dietary fibers content prepared by DM (67.8 and 46.63). These finding may be due to that mango peels and kernels contain polyphenol oxidase and peroxidase activities and they are rich in polyphenols, which are substrates for these enzymes; **Saby John *et al.*, (2003).** Therefore, due to the enzymatic browning, brightness and yellowness of the prepared of mango peels may be decreased as reported by; **Ajila *et al.* (2008).**

Table (7): Color of the mango and orange dietary fiber concentrate prepared by different methods.

Color	Preparation methods			
	DM	**WM**	**WM-C**	**WM-H**
		Mango peels		
L*	53.43a,b±0.34	49.36c±0.43	50.22b±0.54	58.21a±0.06
a*	3.40b±0.24	3.87a±0.28	3.75a±0.76	2.44c±0.37
b*	31.76c±0.03	32.40a±0.27	32.17b±0.03	32.67a±0.27
Chroma	32.76b±0.34	34.03a±0.28	31.49b±0.40	31.37b±0.36
Total Intensity	67.80a±0.05	64.31a±0.36	61.65b±0.05	58.49c±0.76
		Orange peels		
L*	37.49a±0.31	31.46b±0.45	34.79a,b±0.04	28.92b±0.23
a*	3.79b±0.17	5.29a±0.47	5.37a±0.67	3.36b±0.47
b*	19.69b±0.36	22.24a±0.46	22.71a±0.47	15.84c±0.32
Chroma	18.43c±0.27	25.61a±0.45	20.72b±0.28	20.68b±0.26
Total Intensity	46.63a±0.35	42.72a,b±0.27	45.14a±0.38	36.21c±0.36

Numbers followed by the same letter in the same column do not differ significantly by Duncan's multiple rang test (p> 0.05)

IV. Conclusion

Fiber is a mixture of nonstarch polysaccharides that resist digestion by enzymes in the gastro-intestinal canal. Some known methods of extracting fiber from plant sources include dry processing, wet processing, chemical, gravimetric, enzymatic, physical, microbial or a combination of these methods. Modified wet milling is the most cost effective in the wet milling group as it uses minimal chemicals, produces high purity products and uses less water than the other methods. The purity of fibers extracted using the modified wet milling method range from 49.7% – 89.6%. An ideal extraction method should be affordable and produce fibers of high purity. These results indicated that this treatment was the most effective method to provide an opportunity to enhance the functionality of dietary fiber concentrate and hence to use the mango and orange peels dietary fiber concentrate as a low-caloric functional ingredient for fiber enrichment, although the incorporation of them within the food system may slightly affect the color of the final product.

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