The Journal of Animal & Plant Sciences, 27(6): 2017, Page: 2045-2055
ISSN: 1018-7081

CHARACTERIZATION, OXIDATIVE PERSPECTIVES AND CONSUMER ACCEPTABILITY OF TOMATO WASTE POWDER SUPPLEMENTED COOKIES

U. Ahmad[1], Z. Mushtaq[1], R. S. Ahmad[2] and N. Asghar[2]

[1]Department of Food Science, Nutrition & Home Economics, Govt. College University, Faisalabad
[2]Institute of Home and Food Sciences, Faculty of Science and Technology, Govt. College University, Faisalabad
Corresponding author's email: uswa1119@gmail.com

ABSTRACT

Tomato waste products (peels and seeds) are rich source of nutrients and bioactive substances, which play a significant role in enhancing the nutritional profile and prolonging shelf life. For this purpose, the effect of tomato waste powder (TWP) at different replacing levels (2, 4 and 8 %) on the physico-chemical, rancidity and organoleptic properties of cookies at storage intervals of 0, 15, 30 and 45 days were evaluated. Results demonstrated that TWP had high contents of protein (18.96 %), crude fiber (21.03 %), total phenols (48.35 mg GAE/100g) and lycopene (466 µg/100g). All properties of cookies were affected significantly by the addition of TWP from T_1 to T_3. During storage TWP had a non-significant effect on physicochemical properties with the exception of moisture. Rancidity parameters decreased significantly from T_0 (control sample without TWP) to T_3 (Sample with 8% TWP) and increased with storage, but the change was less than control (without TWP). Cookies supplemented with 4% TWP were most liked by judges. Conclusively, TWP could be used to improve storage stability of food products.

Key words: Tomato, Lycopene, Cookies, Physico-chemical, Rancidity.

INTRODUCTION

The tomato (*Lycopersicon esculentum* Mill) of the family Solanaceae is one of the world's most cultivated crop with production of 162 million tons FAOSTAT (2014). Pakistan ranks 35th in tomato production worldwide. In 2011, the area under tomato cultivation was 52.3 thousand hectares, which was approximately 20 % of the total vegetable area resulting in 529.6 thousand tons Govt. of Pakistan (2011-12). The production includes both tomatoes consumed as fresh and industrially processed tomato products. The tomato has been reported to be an important source of carotenoids (in particular, lycopene), ascorbic acid (vitamin C), vitamin E, folate, potassium, flavonoids and phenolic compounds (Akhtar *et al*. 2014). Due to the presence of these compounds, the tomato has protective and curing properties of degenerative diseases, such as cataracts, heart diseases, diabetics, hyperglycaemia, inflammation, arthritis, immune system decline, brain dysfunction, prostate cancer, breast cancer, lungs cancer and maintenance of body homeostasis (Mujtaba *et al.* 2014).

Million tons of tomatoes are processed yearly to produce juice, sauces, purees, pastes, and canned tomatoes, resulting in large amounts of tomato peel and seed as industrial waste (called tomato pomace), which is 4 % of the total fruit weight. Tomato pomace has been used as a low value livestock feed or disposed in controlled landfills, creating environmental issues (Celma *et al.* 2012). Tomato by-products that are abundant source of lycopene can be utilized as a cheap source of lycopene and off-set the cost for further effective management of the remaining wastes. Tomato peels and seeds have multiple nutritional benefits due to their rich source of both macronutrients (protein, fat and fiber) and micronutrients (Zn, Mn and Cu). Bioactive compounds namely carotenoids, specially lycopene, total phenols and total flavonoids, are present in tomato waste 50 % more than whole tomato pulp (Jiang *et al*. 2015). The main carotenoid in tomato waste is lycopene (70–80 %), which produces the red color while types include phytoene (5.3 %), phytofluene (2.8 %), β-carotene (3.7 %), ξ-carotene (0.9 %), γ-carotene (1.2 %) and lutein (2.0 %). Both lycopene and β-carotene are three times higher in skin and peels of tomato and have the ability to act as antioxidants and/or singlet oxygen quenchers. The quenching constant of lycopene in vitro has been shown to be more than double that of β-carotene and 100-fold that of α-tocopherol (Vagi *et al*. 2007).

The lycopene important carotenoid present in tomato waste is quite stable in commercial processing and storage of tomato in terms of both degradation and isomerization (Nasir *et al.* 2015). The importance of natural food compounds is increasing due to increased usage of these compounds in food, cosmetics and pharmaceuticals. The recycling or re-usage of these by-products, accumulated during processing and available in high amounts, can reduce treatment costs. Obtaining carotenoids, such as lycopene from tomato peel and seeds, is a viable approach for the re-usage of these wastes produced from the tomato industries. In order to obtain a wide range of health benefits from tomato wastes, it is expected that the waste can be infused in some manner as into functional components in food, nutraceutical or cosmetic products (Vagi *et al*. 2007). Moreover, the nutritive and antioxidant importance of tomato waste powder provides excellent potential for processing into important food delicacies, such as ketchup, sausages, hum burgers, candies, bread and dairy products (Calvo *et al.* 2008; Luisa Garcia *et al.* 2009; Bajerska *et al.* 2014). Tomato waste (peel and seeds) powder (TWP) has already been supplemented in flours that include wheat flour, barley flour, grape flour and corn flour (Sogi *et al*. 2002; Altan *et al*. 2008). Addition of TWP in food products resulted in improved nutritional and storage stability. In Pakistan, many local industries, such as Michelle's, National, Shangrilla and Sundrip, are producing several tomato products, including sauces, purees, pastes and ketchup Despite the potential benefits exerted by the remaining nutrients, the tomato waste products are disposed or used as animal feed. Therefore, the main mandate of this study was to characterize the TWP for the development and consumer acceptability as functional product rich in antioxidants.

MATERIALS AND METHODS

Preparation of Raw Material: Fully ripe fresh tomatoes (*Lycopersicon esculentum* Mill) (surface area with more than 90 % red color), without any visual defects, were collected from Agricultural farm of Faisalabad city, Pakistan. Tomatoes were washed by water to remove dust and unwanted particles from the surface, boiled at 85˚C temperature for 10 minutes. After boiling, peel and seeds of tomatoes were removed (Hasanuzzaman *et al.* 2014). Peel and seeds of tomatoes were dried in oven at 60 ºC. After drying, all material was milled into fine powder and stored in desiccators for later use (Kumar *et al.* 2011). Analytical grade chemicals were purchased from Sigma-Aldrich Chemie GmbH, Germany.

Characterization of tomato waste powder: The tomato waste powder (TWP) was chemically analyzed for proximate composition. Moisture content was analyzed by using air forced draft oven (Model: DO-1-30/02, PCSIR, Pakistan) by the Method No. 934.01 (AOAC 2006). Protein was calculated by the Method No. 990.03 AOAC (2006). Crude fat was estimated by AOAC (2006) Method No. 954-02. Samples were examined for crude fiber as described by AOAC (2006) Method No. 978.10. For determination of ash content, the AOAC (2006) Method No. 942.05 was used.

Preparation of tomato waste extract: Ethanolic extract of TWP was prepared by adding 120 ml ethanol, 30 ml distilled water in 15 g dried TWP. The samples were placed in orbital shaker for 6-8 hours at 240 rmp at room temperature according to AOCS (1998). The supernatant from each flask was then filtered with what man No. 1 filter paper. The solvent from the supernatant was separated at 50ºC in a rotary vacuum evaporator (EYELA, N-N series, Japan) leaving behind a crude extract. The extract of each sample was weighted to determine the yield of the extract and stored at 4ºC until use.

Total phenolic contents: Total phenolic contents were completed by using Folin-Ciocalteu method as described by Chan *et al.* (2008).

Lycopene contents: Extraction and quantitative of lycopene were conducted according to Fish *et al.* (2002) using a mixture of hexane: ethanol: acetone (v/v/v 2:1:1) containing 0.05% of BHT.

Development and characterization of functional product: The baking process of cookies was completed with blends of 2 % (T_1), 4 % (T_2), and 8 % (T_3) and T_0 (control sample without TWP), which were prepared by substituting flours in the cookie formulation with TWP, according to the method No. 10-50D AACC (2000) with slight modifications. The basic ingredients used were 200 g of composite flour, 100 g shortening, 100 g of granulated cane sugar, 1 g of beaten whole egg and 3 g of baking powder. The dry ingredients were weighed and mixed thoroughly in a bowl by hand for 3-5 min. Shortening was added and rubbed in until uniform. The egg was added and dough was thoroughly kneaded in a mixer for 5 min. The dough was rolled thinly on a sheeting board to a uniform thickness of 3 inches and 1 inch in diameter followed by cutting with a biscuit cutter. The cookies were baked on greased pans at 220ºC for 10 min in a baking oven. The prepared cookies were cooled to room temperature (30±2º C) and packed in high density polyethylene bags.

Chemical analysis: The cookies were analyzed for proximate composition according to the methods provided in AOAC (2006).

Rancidity tests: Rancidity tests that included free fatty acid (method No. 940.28), peroxide value (method No. 965.33) and saponification value (method No. 920.160) were analysed by following the methodology of AOAC (2000) at 0 day interval up to a storage period of 45 days at room temperature. Each of these methods are described below.

Free fatty acid determination: A crushed cookies sample (0.2 g) was dissolved in 10 ml ethanol and titrated with 0.1M NaOH solution using phenolphthalein indicator until the pink colour disappeared. The acid value and the percentage fatty acid were calculated from the expression below:

Acid Value = 56 × morality of NaOH × titre value / weight of sample (g)

% Free Fatty Acid as Oleic acid= 0.503 × Acid Value

Peroxide value: A crushed cookies sample (5.0 g) was weighed into a 250 ml conical flask, dissolved with 30 ml solvent mixture containing 12 ml chloroform and 18 ml glacial acetic acid. After the addition of saturated aqueous potassium iodide solution (0.5 ml), the flask was stoppered and allowed to stand for one minute. Thereafter, 30 ml of distilled water was added and the solution was titrated against 0.1 M sodium thiosulphate solution until the yellow colour had almost disappeared. At this point, starch solution (0.5 ml) was added and the titration continued until the blue-black colour disappeared. The same procedure completed for a 'blank' determination, where the oil sample was excluded. The peroxide value was calculated by using expression below:
PV (meq/100g) = (B-S) × M × 100/ weight of sample (g)
where;
meq/100g = milliequivalent peroxide/100g sample
S = Titre value (ml) of sodium thiosulphate for sample
B = Titre value (ml) of sodium thiosulphate for blank,
M = Molarity of sodium thiosulphate solution Calculated the peroxide value by the formula:

Saponification value: A sample of crushed cookies (1.5 to 2.0 g) was transferred to al 250 ml Erlenmeyer flask, and 25 ml of alcoholic potassium hydroxide was added to the flask. A blank determination was conducted along with sample. Each was connected with air condensers, kept in a water bath, boiled gently but steadily until clear solution formed. After the flask and condenser cooled down, the condenser was washed with 10 ml of hot ethyl alcohol neutral to phenolphthalein. The sample was titrated with excess potassium hydroxide or 0.5 N hydrochloric acid, using about 1.0 ml phenolphthalein as indicator AOAC (2000). Saponification value was calculated by using the following formula:
SV= 56.1(B-S) N /weight of sample (g)
Where;
B= ml of hydrochloric acid required for blank sample
S= ml of hydrochloric acid required for the sample
N= Normality of the standard hydrochloric acid

Physical parameters: The physical parameters, such as, diameter, thickness and spread factor were analyzed following the methodology of AACC (2000) at 0 day interval up to a storage period of 45 days at room temperature. The diameter (mm) of six cookies was determined by placing the cookies next to each other horizontally, and the total diameter was measured. The thickness (mm) was measured by placing six cookies on one another, and the total height was measured. The tests were repeated thrice to bring meticulousness. The spread factor was calculated according to the formula, i.e., SF = D/T, and the evaluation of texture expressed as breaking strength was measured by using the three-point bend rig technique by a texture analyzer (TA-TX2i Plus, Stable Micro System Surrey, UK) (Piga *et al*. 2005).

Color measurement: The color of both sides of TWP cookies was measured using a Hunter's Lab color analyzer. Using a Hunter's lab colorimeter, the color of a sample is denoted by the three dimensions, L*, a* and b*, which corresponds to the lightness, redness/greenness and yellowness/ blueness of the product, respectively. In addition, a 45 storage study was also completed (Kumar *et al.* 2011).

Organoleptic evaluation of functional product: The organoleptic evaluation of functional cookies was completed in room temperature (25^{o}C) according to Meilgaard *et al.* (2007). Fourteen judges panel consisting of experienced and untrained panelists was selected for assessing the samples. Each judge provided written informed consent after an explanation of risks and benefits of participation prior to the study. Each panelist was offered samples randomly from experimental treatments placed in closed plastic dishes labeled with three secret digit codes. Prior to evaluation, the panelists were provided informative instructions and brief definitions of attributes such as color, flavor, taste, texture and overall acceptability. Each panelist was asked to list their preference on a 9-point Hedonic scale (where 1=dislike extremely and 9=like extremely) on fortnightly basis for consecutive 45 days.

Data analysis: Data obtained was statistically analyzed using descriptive statistics and interpreted by analysis of variance (ANOVA) using M-Stat C software® package. LSD test was used to determine the level of significance between the mean values of experimental samples (Steel *et al.* 1997).

RESULTS AND DISCUSSION

Chemical Composition of Raw Material: The fresh tomatoes purchased for the separation of peels and seeds from whole tomatoes had an average weight of 500±4.50 g, from which pulp, peels and seeds weights were 200±1.77 g, 135±1.20 g and 165±1.45 g respectively. The different varieties of tomato exhibited considerable variation for floral, vegetative, physico-chemical attributes and yield of peels and seeds of tomato (Toor *et al.* 2005). The significant results of tomato waste (peel and seeds) powder (TWP) analyzed for chemical analysis (moisture, crude protein and ash and crude fiber contents) are presented in Table 1. Alvarado *et al.* (2001) stated that tomato peel and seeds after drying and grinding contained 101.4 g water, 175.6 g protein, 95.9 g lipids and 36.4 g ash per kilogram of residue. Valle *et al.* (2006) reported that tomato pomace (peel and seeds) contained high amount of protein (19.27 %), fat (5.85 %), fiber (59.03 %) and mineral contents (3.92 %) on dry weight basis. It is also evident from other previous research that tomato pomace (peel and seeds) had high amount of protein, fat, fiber and mineral contents on dry weight basis (Chumpawadee *et al*. 2007; Abbeddou *et al.* 2011). The differences in values may be due to different tomato cultivars, growing and processing conditions. The chemical analyses results indicate that TWP is a nutritious and has the potential for further development into functional products for discerning consumers.

Phytochemical Tests

Total Phenolic and lycopene contents: Tomato processing by-products (peels and seeds) are rich source of total phenolic and lycopene contents as compared to the tomato pulp (Kalogeropoulos *et al*. (2012). Table 1 showed that tomato waste powder is rich source of total phenolic and lycopene contents.

Toor *et al.* (2005) and Fuentes *et al.* (2013) reported that tomato peel and seeds powder had higher amount of phenolic contents than pulp. However, according to Knoblick *et al.* (2005) and Choudhari and Anantharayan (2007) TWP had higher concentration of lycopene than the whole tomato pulp.

Chemical Composition of Functional Product: The effect of different treatments and storage on chemical composition of TWP cookies are presented in Table 2. According to results, there is a highly significant change in moisture, ash, fiber, fat and protein contents of cookies with the addition of TWP. Among the treatments, the lowest moisture (3.29±0.09 %), protein (6.47±0.02 %), crude fiber (0.13±0.001 %), ash (0.54±0.004 %) and fat (23.46±0.11 %) contents occurred for the T_0 (control) (Table 2). However, the highest concentration of moisture (3.93±0.03 %), protein (7.98±0.04 %), crude fiber (1.81±0.002 %), ash (0.73±0.002 %) and fat (23.93±0.24 %) contents were recorded in T_3 (cookies with 8 % TWP). This variation is expected due to differences in the amounts of TWP that had higher moisture, protein, fiber, ash and fat levels (Valle *et al.* 2006). Therefore, the concentration of these nutrients in TWP cookies increased gradually by the addition of TWP.

A significant increasing trend was noted for moisture ($p< 0.05$) with non-significant changes in crude protein, crude fat, crude fiber and ash contents for all treatments during storage (Table 2). Increase in moisture content and decrease in other parameters may be associated with higher water absorption due to presence of more fiber present in TWP. The results are in close agreement with the findings of Masih *et al*. (2014).

Rancidity Properties of Cookies

Measuring Free Fatty Acids (FFA), Peroxide Value (PV) and Saponification Value (SV): In the present study, rancidity in cookies samples were determined by measuring free fatty acid, peroxide value, and saponification value with and without TWP for 45 days of storage. The treatments and storage period altered free fatty acid, peroxide value and saponification value significantly with the addition of TWP in cookies as shown in Figures 1, 2 and 3. Among the treatment, the highest values of FFA (0.12±0.04 %), PV (0.15±0.02 meq/100 g) and SV (180±1.24 mg KOH/100 g) were occurred for T_0 (control). Alternatively, lowest values of FFA (0.07 ±0.01 %), PV (0.09±0.02 meq/100 g) and SV (165±1.63 mg KOH/100 g) were recorded for T_3. With increasing concentrations of TWP, the values of free fatty acid, peroxide and saponification values significantly decreased from T_0 to T_3 due to presence of natural antioxidants, such as phenols and carotenoids and specially lycopene that exhibits higher singlet oxygen (O_2) quenching ability as compared to other antioxidants, which may helpful in preventing oxidation (Rizk *et al.* 2014; Stajcic *et al.* 2015).

During 45 days of storage FFA, PV and SV of TWP cookies increased significantly (Figure 1, 2 and 3) but that change was less than control. Values of FFA, PV and SV of TWP cookies may increase due to presence of high amount of fat and fiber in TWP (Valle *et al.* 2006). This indicates that shortening in cookies was oxidized, and the first and second oxidation products, such as peroxides, ketones, aldehydes, and alcohols, were produced (Noorolahi *et al.* 2012).

The results are comparable with Al-sayed and Ahmad (2013) and Ismail *et al.* (2014) who studied the effect of antioxidants present in watermelon rinds, sharlyn melon peels and pomegranate peel on durability of bakery products. These researchers determined that these waste products may reduce the oxidative degradation in bakery products.

Physical Properties of Cookies: The physical parameters studied include diameter, spread ratio, breaking strength, thickness and color value. The results obtained for effect of treatments on the mechanical properties of cookies are presented in Table 3. The mean of treatments indicated that the physical parameters of TWP cookies were significantly affected as a function of their ingredient. Maximum diameter (81.76±0.01mm) and minimum thickness (8.92±0.01mm) were observed in T_0 (control) while minimum diameter (74.52±0.12 mm) and maximum thickness (10.22±0.05 mm) were recorded in T_3 (8 % TWP). This decrease in the width and increase in the thickness was due to the presence of more fiber that has high water absorption capacity. In fiber, because oligosaccharide the attracts water, the dough viscosity increased that resulting in increased thickness and decreased diameter (Turksoy *et al.* 2011).

Cookies spread ratio represents a ratio of diameter to thickness. It is apparent (Table 3) that significant differences among treatments existed; Maximum spread factor (9.12±0.01 mm) and minimum breaking strength (9.31±0.04) occurred in T_0 (control) while minimum spread factor (7.29±0.02 mm) and maximum breaking strength (9.67±0.004) was recorded in T_3.

Srivastava *et al.* (2014) determined that pomegranate peel powder cookies spread ratio decreased and breaking strength increased due to high water absorption capacity of fiber present in pomegranate peel powder, which absorbed water during dough mixing, increased the dough viscosity and reduced the cookie spread.

The influence of storage on the diameter, thickness, spread ratio and breaking strength of cookies prepared from waste powder are provided in the Table 3. During storage physical parameters of cookies decreased but that change was non-significant. The result nearly matched of the results reported by Mushtaq *et al.* (2010) and Rehman *et al.* (2013) who demonstrated that the change in physical parameters of cookies and rusks were due to increase in moisture contents with the passage of time.

Color: The color of cookies is one of the characteristics that affect the acceptability of end product by the consumer. As such, the surface color, L* (brightness), a* (redness) and b* (yellowness) values of cookies samples were measured and their values are shown in Table 4. In general, tomato waste powder addition in cookies considerably decreased the "L*" and "b*" values, while "a*" values increased in the TWP containing cookies. The effect of the tomato waste (peel and seeds) powder (TWP) on the color characteristics of cookies were due to presence of red colored carotenoids (e.g. β-carotene and lycopene) that impart an orange color (Chantaro *et al.* 2008). Therefore, when TWP was added to the flour, cookies became darker and the creamy-yellow color of the control samples turned into orange-yellow.

During 45 days of storage, L*, a* and b* of TWP cookies decreased but that change was non-significant (Table 4). These results are in accordance with Mushtaq *et al.* (2010) who reported the decreased in color values of cookies due to presence of more fiber that had high water absorption capacity.

Organoleptic Evaluation: One of the most important criteria to assess the quality and acceptability of product development is its organoleptic evaluation. The organoleptic evaluation is of major reflection and is conducted to evaluate the reply of judges/consumers towards the end product (Meilgaard *et al.* 2007). Results pertaining to organoleptic evaluation of cookies are presented in the Table 5. Statistical analysis depicts that organoleptic evaluation parameters of cookies. Including color, taste, flavor, texture and overall acceptability, were affected significantly as a function of treatments and storage periods.

Organoleptic evaluation studies showed that the surface color and appearance of cookies containing up to 4 % of TWP were as acceptable as those of control cookies (Table 5). As the percentage of the incorporation of tomato waste (peel and seeds) powder (TWP) increased the surface color of the darker cookies due to presence of carotenoids (in particular, lycopene). These obtained results align with those of Turkosy *et al.* (2011).

However, the results also showed that cookies had acceptable texture up to 4 % TWP as those of control cookies (cookies with 100 % wheat flour) (Table 5). The hardness of the higher supplemented cookies increased relatively as compared to the control cookies samples due to higher water holding capacity.

The taste and flavor of cookies with 4 % TWP was regarded as most acceptable as control cookies. Both taste and flavor of TWP cookies decreased with the addition of TWP due to high carotenoids content. These data are support the results reported by with Arshad *et al.* (2014) who prepared cookies with multigrain.

Regarding to overall quality, it could be noted that cookies incorporated with TWP up to 4 % (T_2) showed higher scores as those of control (Table 5). The lower score values of TWP cookies could be due to the unattractive color and the unpleasant taste. It could be concluded that cookies with most acceptable overall quality can be prepared by substituted 4 % of TWP. Similar results were also reported by Bertagnolli *et al.* (2014).

During storage color, taste, texture, flavor and overall acceptability of TWP cookies decreased from T_0 to T_3 (Table 6). Results of present investigation are in corroboration with the results presented by Pasha *et al.* (2002) and Sharif *et al.* (2005) who associated the changes in organoleptic evaluation parameters with the absorption of moisture, generation of free fatty acids and increase in peroxide value in cookies during storage.

Table 1. Chemical composition and phytochemical tests of TWP

Chemical composition	**Moisture content (%)**	7.22±0.04
	Crude protein (%)	18.96±0.05
	Crude fiber (%)	21.03±1.63
	Ash content (%)	3.54±0.03
	Fat content (%)	5.96±0.02
Phytochemical Tests	**Total phenolic content (mg GAE/g)**	48.35±1.25
	Lycopene content (µg/g)	466±0.64

Table 2. Chemical composition of TWP cookies

		Treatments	Storage Period			
			0 days	**15 days**	**30 days**	**45 days**
CHEMICAL COMPOSITION	**Moisture (%)**	T_0	3.29±0.02Dd	3.34±0.01Dc	3.40 ±0.04Db	3.46 ±0.05Da
		T_1	3.41±0.03Cd	3.46±0.05Cc	3.51±0.04Cb	3.56±0.05Ca
		T_2	3.55±0.02Bd	3.59±0.02Bc	3.63±0.03Bb	3.68±0.03Ba
		T_3	3.85±0.02Ad	3.89±0.04Ac	3.93±0.03Ab	3.98±0.03Aa
	Crude protein (%)	T_0	6.47±0.06D	6.47±0.06D	6.46±0.04D	6.45±0.02D
		T_1	6.84±0.03C	6.83±0.02C	6.83±0.02C	6.82±0.02C
		T_2	7.22±0.05B	7.21±0.03B	7.21±0.03B	7.20±0.04B
		T_3	7.98±0.04A	7.98±0.02A	7.97±0.01A	7.97±0.01A
	Crude fiber (%)	T_0	0.13±0.004D	0.12±0.004D	0.11±0.008D	0.10±0.004D
		T_1	0.55 ±0.004C	0.55 ±0.004C	0.54 ±0.004C	0.53 ±0.008C
		T_2	0.97±0.004B	0.96±0.009B	0.96±0.009B	0.95±0.004B
		T_3	1.81±0.008A	1.81±0.008A	1.80±0.009A	1.80±0.009A
	Crude ash (%)	T_0	0.45 ±0.008D	0.44±0.004D	0.43±0.004D	0.42±0.008D
		T_1	0.52 ±0.004C	0.51 ±0.008C	0.51±0.008C	0.50±0.004C
		T_2	0.59 ±0.008B	0.58 ±0.008B	0.58 ±0.008B	0.57±0.004B
		T_3	0.73 ±0.004A	0.73 ±0.004A	0.72 ±0.004A	0.72 ±0.004A
	Crude Fat (%)	T_0	23.46±0.06D	23.45±0.04D	23.44±0.07D	23.43±0.03D
		T_1	23.57±0.07C	23.56±0.04C	23.56±0.04C	23.55±0.02C
		T_2	23.69±0.07B	23.68±0.05B	23.68±0.05B	23.67±0.06B
		T_3	23.93±0.05A	23.93±0.05A	23.92±0.04A	23.92±0.04A

Values are mean ± standard error, analyzed individually in triplicate.
Mean followed by different upper case letters in the same columns represent significant difference ($P < 0.05$) among treatments.
Mean followed by different lower case letters in the same rows represent significant difference ($P < 0.05$) at 45 days storage period.
T_0= Cookies without TWP (control)
T_1= Cookies with 2 % TWP
T_2=Cookies with 4 % TWP
T_3=Cookies with 8 % TWP

Table 3. Physical parameters of TWP cookies

		Treatments	Storage Period			
			0 days	**15 days**	**30 days**	**45 days**
PHYSICAL PARAMETERS	**Diameter (mm)**	T_0	81.74±0.01A	81.73±0.00A	81.71±0.004A	81.69±0.008A
		T_1	79.04±0.004B	79.02±0.008B	79.01±0.009B	79.00±0.004B
		T_2	76.31±0.009C	76.30±0.004C	76.29±0.008C	76.28±0.004C
		T_3	74.52±0.12D	74.43±0.008D	74.41 ±0.01D	74.41 ±0.01D
	Thickness (mm)	T_0	8.92±0.01D	8.91±0.12D	8.90±0.01D	8.89±0.01D
		T_1	9.14±0.04C	9.11±0.07C	9.10±0.008C	9.09±0.004C
		T_2	9.72±0.01B	9.72±0.004B	9.71±0.008B	9.70±0.008B
		T_3	10.22±0.05A	10.22±0.05A	10.21±0.03A	10.21±0.03A
	Spread ratio (mm)	T_0	9.12±0.01A	9.11±0.008A	9.10±0.004A	9.09±1.40A
		T_1	8.68±0.004B	8.65±.0.07B	8.63±0.02B	8.62±0.01B

		T_2	7.81±0.01C	7.81±0.008C	7.80±0.008C	7.79±0.004C
		T_3	7.29±0.02D	7.29±0.004D	7.28±0.008D	7.28±0.008D
	Breaking strength (F, N)	T_0	9.06±0.01D	9.05±0.004D	9.04±0.004D	9.03±0.008D
		T_1	9.31 ±0.04C	9.30±0.004C	9.28±0.01C	9.28±0.01C
		T_2	9.46 ±0.004B	9.45±0.004B	9.44±0.009B	9.43±0.008B
		T_3	9.67 ±0.004A	9.67±0.004A	9.66±0.003A	9.66±0.003A

Values are mean ± standard error, analyzed individually in triplicate.
Mean followed by different upper case letters in the same columns represent significant difference (P < 0.05) among treatments.
T_0= Cookies without TWP (control)
T_1= Cookies with 2 % TWP
T_2=Cookies with 4 % TWP
T_3=Cookies with 8 % TWP

Table 4. Color parameter of TWP cookies

	Treatments		Storage Period			
			0 days	15 days	30 days	45 days
COLOR	**L***	T_0	70.18±0.22A	70.17 ±0.01A	70.16±0.02A	70.14±0.03A
		T_1	64. 54±0.008B	64.54±0.008B	64.52±0.01B	64.51±0.01B
		T_2	63. 22±0.008C	63.21±0.008C	63.21±0.008C	63.19±0.008C
		T_3	62. 87±0.008D	62.87±0.01D	62.86±0.008D	62.86±0.004D
	a*	T_0	3.22±0.008D	3.21±0.007D	3.20±0.005D	3.18±0.01D
		T_1	12.20±0.01C	12.19±0.004C	12.19±0.05C	12.18±0.06C
		T_2	13.44±0.01B	13.41±0.01B	13.41±0.008B	13.40±0.008B
		T_3	14.93±0.01A	14.93±0.01A	14.92±0.24A	14.92±0.01A
	b*	T_0	23.91±0.01A	23.90±0.04A	23.89±0.03A	23.88±0.008A
		T_1	20.46±0.01B	20.45±0.02B	20.44±0.02B	20.44±0.02B
		T_2	19.54±0.005C	19.53±0.004C	19.53±0.004C	19.52±0.04C
		T_3	19.02±0.02D	19.02±0.008D	19.01±0.09D	19.01±0.09D

Values are mean ± standard error, analyzed individually in triplicate.
Mean followed by different upper case letters in the same columns represent significant difference (P < 0.05) among treatments.
T_0= Cookies without TWP (control)
T_1= Cookies with 2 % TWP
T_2=Cookies with 4 % TWP
T_3=Cookies with 8 % TWP

Table 5. Organoleptic evaluation of TWP cookies

	Treatments		Storage Period			
			0 days	15 days	30 days	45 days
ORGANOLEPTIC EVALUATION	**Color**	T_0	7.02 ±0.02Aa	6.82±0.04Ab	6.62±0.08Ac	6.42±0.08Ad
		T_1	6.68 ±0.04Ca	6.46±0.01Cb	6.24±0.03Cc	6.02±0.01Cd
		T_2	6.82 ±0.03Ba	6.61±0.02Bb	6.40±0.03Bc	6.19±0.02Bd
		T_3	6.18±0.03Da	5.94±0.04Db	5.70±0.05Dc	5.46±0.07Dd
	Taste	T_0	7.04±0.04Aa	6.74±0.08Ab	6.44±0.08Ac	6.14±0.08Ad
		T_1	6.46 ±0.04Ca	6.14±0.15Cb	5.82±0.30Cc	5.50±0.42Cd
		T_2	6.70 ±0.02Ba	6.39±0.02Bb	6.08±0.01Bc	5.77±0.01Bd
		T_3	5.96±0.05Da	5.62±0.04Db	5.28±0.03Dc	4.94±0.02Dd
	Texture	T_0	8.04±0.04Aa	7.64±0.08Ab	7.24 ±0.02Ac	6.84±0.08Ad
		T_1	7.32 ±0.07Ca	6.90±0.03Cb	6.48 ±0.01Cc	6.06 ±0.02Cd
		T_2	7.55 ±0.02Ba	7.14 ±0.08Bb	6.73 ±0.01Bc	6.32 ±0.02Bd
		T_3	6.82±0.03Da	6.38±0.02Db	5.94±0.02Dc	5.50±0.02Dd
	Flavor	T_0	7.50±0.08Aa	7.20±0.02Ab	6.90±0.04Ac	6.60±0.08Ad
		T_1	7.15 ±0.04Ca	6.83±0.03Cb	6.51 ±0.01Cc	6.19 ±0.02Cd
		T_2	7.21 ±0.02Ba	6.90±0.04Bb	6.59±0.04Bc	6.28 ± 0.02Bd
		T_3	6.65±0.04Da	6.31±0.04Db	5.97±0.04Dc	5.63±0.04Dd
	Overall	T_0	7.37±0.08Aa	7.10±0.08Ab	6.83±0.08Ac	6.56±0.08Ad

acceptability	T_1	7.18 ±0.04Ca	6.89 ±0.04Cb	6.60±0.04Cc	6.31 ±0.02Cd
	T_2	7.22±0.02Ba	6.94±0.04Bb	6.66±0.04Bc	6.38±0.04Bd
	T_3	6.68 ±0.04Da	6.37±0.01Db	6.06±0.03Dc	5.75±0.01Dd

Values are mean ± standard error, analyzed individually in triplicate.
Mean followed by different upper case letters in the same columns represent significant difference (P < 0.05) among treatments.
Mean followed by different lower case letters in the same rows represent significant difference (P < 0.05) at 45 days storage period.
T_0= Cookies without TWP (control)
T_1= Cookies with 2 % TWP
T_2=Cookies with 4 % TWP
T_3=Cookies with 8 % TWP

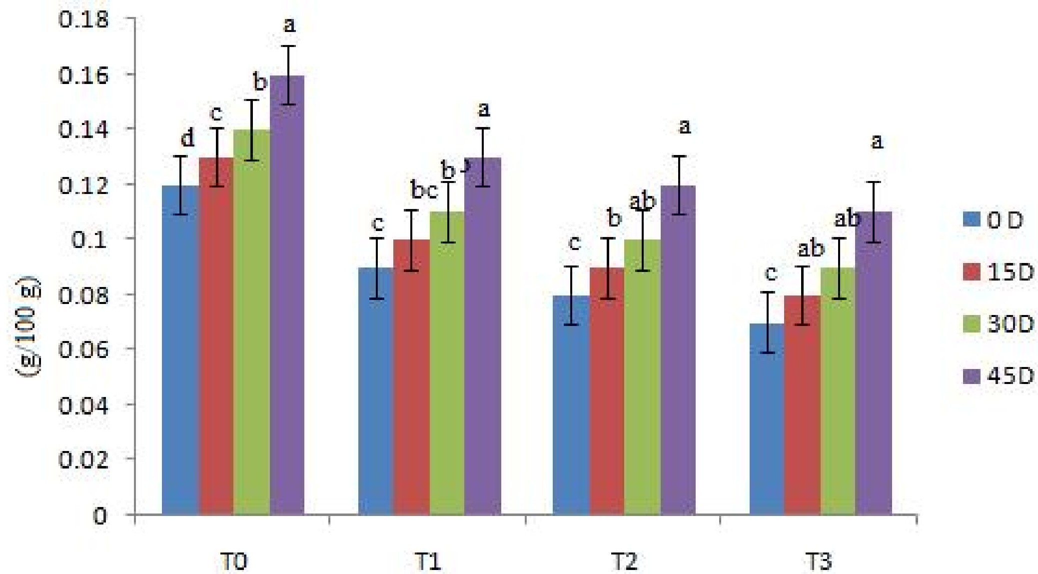

Figure 1: Effect of Storage on FFA content of TWP cookies (g/100 g oil)
Values represent mean ± S.E.R. n=3. FFA of TWP cookies were significantly (P < 0.05) different from control cookies.

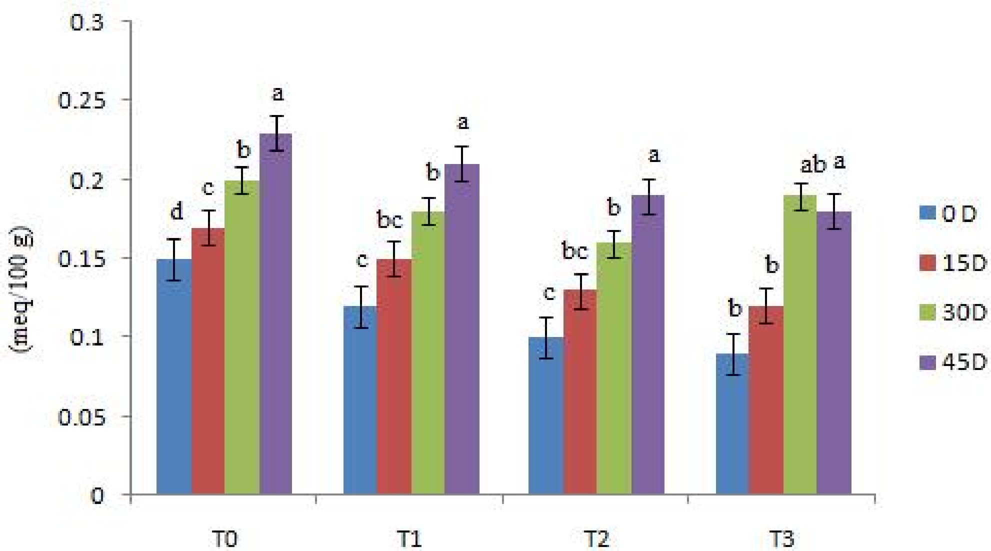

Figure 2: Effect of Storage on PV of TWP cookies (meq/100 g product)
Values represent mean ± S.E.R. n=3. PV of TWP cookies were significantly (P < 0.05) different from control cookies.

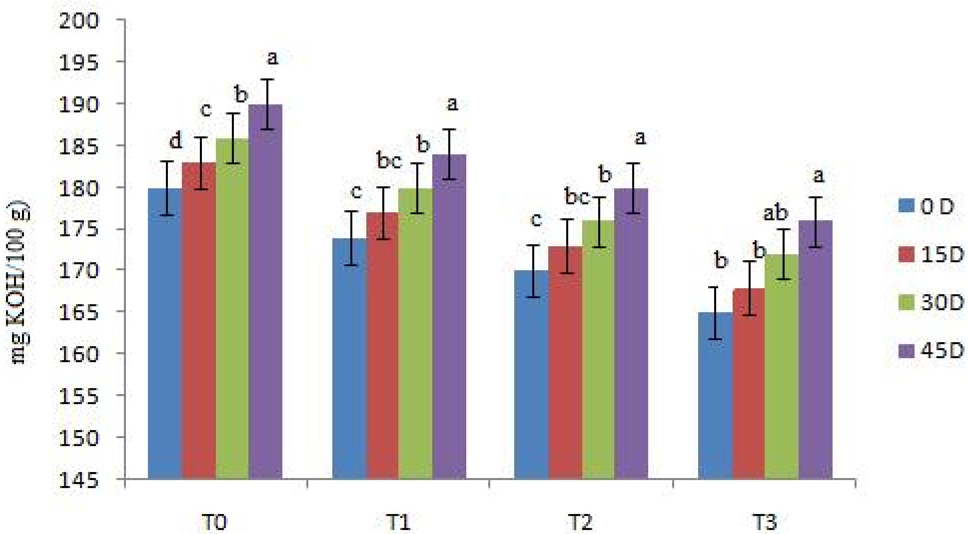

Figure 3: Effect of storage on SV of TWP cookies (mg KOH/100 g product).
Values represent mean ± S.E.R. n=3. SV of TWP cookies were significantly ($P < 0.05$) different from control cookies.

Conclusion: Every year, fruit processing industry a waste sterm that contains considerable levels of bio-active material that can play a vital role to cure and prevent many diseases. In the present study, TWP was incorporated in cookies in three different concentrations (2, 4 and 8 %), and TWP cookies were analyzed for physicochemical, antioxidant and organoleptic properties at 45 days storage interval. Due to incorporation of TWP physicochemical, antioxidant and organoleptic properties of cookies improved. It can thus be concluded that TWP improved the quality of food products and also increased their shelf life.

Practical Applications: Food processing industries produce large amount of wastes that are disposed and not properly utilized. These wastes are a rich source for essential indigestible components and bioactive compounds. The present study focuses on the utilization of these waste products in bakery products to improve nutritional, physiological and antioxidant potential of the food product and can be beneficial as economic resource to develop dietary interventions.

Acknowledgements: The authors are thankful to the Institute of Home and Food Sciences, Government College University Faisalabad Pakistan for providing research facilities to prepare this valuable document.

REFERENCES

AACC. (2000). Approved Methods of American Association of Cereal Chemists, the American Association of Cereal Chemistry. Inc., St. Paul, MN.

AOAC. (2006). Official Methods of Analysis of the Association of Official Analytical Chemists, 18th Ed. AOAC Press, Arlington, VA, USA.

AOCS. (1998). Official methods and recommended practices of the American oil chemists, society. 5th Ed. Campaign. III, AOCS.

AOAC. (2000). Official methods of analysis of the Association of Official Analytical Chemists 17th Ed.; AOAC International, Gaithersburg, MD.

Abbeddou, S., S. Riwahi, L. Iniguez, M. Zaklouta, H.D. Hess, and M. Kreuzer (2011). Ruminal degradability, digestibility, energy content and influence on nitrogen turnover of various mediterranean by-products in fat-tailed awassi sheep. Anim. Feed Sci. Tech. 163(2-4): 99-110.

Akhtar, S., J. Ali, F. A. Khan, B. Javid, S. Hassan, and S. Abbas (2014). Preparation of Instant Tomato Ketchup Powder and Comparison of its Physiochemical Composition with Different Brands of Tomato Ketchup Available in Market. Am-Euras. J. Agric. Environ. Sci. 14(3): 190-192.

Al-Sayed, H. M. A. and A. R. Ahmad (2013). Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. Ann. Agric. Sci. 58(1):83-95.

Altan, A., K. L. Mc Carthy, and M. Maskan (2008). Evaluation of snack foods from barley–tomato pomace blends by extrusion processing. J. Food Eng. 84(2):231-242.

Arshad, U., F. M. Anjum, S. Rehman, and M. Sohaib (2014). Development and characterization of multigrain cookies. Pakistan J. Food Sci. 24(1):1-5.

Alvarado, A., E. P. Delahaye, and Hevia, P (2001). Value of a tomato byproduct as a source of dietary fiber in rats. Plant. Foods. Hum Nutr. 56(4): 335-348.

Bajerska, J., A. Chmurzynska, S. Mildner-Szkudlarz, and S. Drzmala-Czyz (2014). Effect of rye bread enriched with tomato pomace on fat absorption and lipid metabolism in rats fed a high-fat diet. J. Sci. Food Agric. 95(9):1918-1924.

Bertagnolli, S. M. M., M. L. R. Silveira, A. D. O. Fogaça, L. Umann, and N. G. Penna (2014). Bioactive compounds and acceptance of cookies made with Guava peel flour. J. Food Sci. Technol. 34(2): 303-308.

Calvo, M. M., M. L. Garcia, and M. D. Selgas (2008). Dry fermented sausages enriched with lycopene from tomato peel. Meat Sci. 80(2):167-172.

Celma, A. R., F. Cuadros, and F. Lopez-Rodriguez (2012). Characterization of pellets from industrial tomato residues. Food Bio prod. Process. 90(4):700-706.

Chan, E. W. C., Y.Y. Lim, L. F. Wong, F. S. Lianto, S. K. Wong, K.K. Lim, C.E. Joe, and T.Y. Lim (2008). Antioxidant and tyrosinase inhibition properties of leaves and rhizomes of ginger species. Food Chem. 109:477-483.

Chantaro, P., S. Devahastin, and N. Chiewchan, (2008). Production of antioxidant high dietary fibre powder from carrot peels. LWT Food Sci. Technol. 41:1987-1994.

Choudhari, S. M. and L. Ananthanarayan (2007). Enzyme aided extraction of lycopene from tomato tissues. Food Chem. 102(1):77-81.

Chumpawadee, S., A. Chantiratikul, and P. Chantiratikul (2007). Chemical composition and nutritional evaluation of energy feeds for ruminants using an invitro gas production technique. Pakistan J. Nutr. 6(6):607-612.

Fish, W.W., P. Perkins-Veazie, and J. K. Collins (2002). A quantitative assay for lycopene that utilizes reduced volumes of organic solvents. J. Food Compost Anal. 15(3): 309-317.

Fuentes, E., R. Carle, L. Astudillo, L. Guzman, M. Gutierrez, G. Carrasco, and I. Palomo (2013). Antioxidant and antiplatelet activities in extracts from green and fully ripe tomato fruits (Solanum lycopersium) and pomace from industrial tomato processing. Evid. Based. Complement. Alternat. 1-9.

FAO. (2014). FAOSTAT. Food and Agriculture Organization of the United Nations.

Garcia, M. L., M.M. Calvo, and M. D. Selgas (2009). Beef hamburgers enriched in lycopene using dry tomato peel as an ingredient. Meat Sci. 83(1):45-49.

Govt. of Pakistan. (2011-12). Agricultural Statistics of Pakistan. Ministry of Food and Agricultural Division (Planning unit), Government of Pakistan, Islamabad.

Hasanuzzaman, M., M. Kamruzzaman, M. M. Islam, S. A. A. Ara Khanom, M. M. Rahman, L. A. Lisa, and D. K. Paul (2014). A study on tomato candy prepared by dehydration technique using different sugar solutions. J. Food Nutri. Sci. 5:1261-1271.

Ismail, T., S. Akhtar, M. Riaz, and A. Ismail (2014). Effect of pomegranate peel supplementation on nutritional, organoleptic and stability properties of cookies. Inter. J. Food Sci. Nutr. 65(6): 661-666.

Jiang, F., Y. L Hsieh (2015). Cellulose non-crystal isolation from tomato peels and assembled nanofibers. Carbohydr Polym. 122:60-68.

Kumar, N., B. C. Sarkar, and H. K. Sharma (2011). Effect of air velocity on kinetics of thin layer carrot pomace drying. Food Sci. Technol. Int. 17(5):459-469.

Kalogeropoulos, N., A. Chiou, V. Pyriochou, A. Peristeraki, and V. T. Karathanos (2012). Bioactive phytochemical in industrial tomatoes and their processing by-products. LWT-Food Sci.Technol. 49(2):213-216.

Knoblich, M., B. Anderson, and D. Latshaw (2005). Analyses of tomato peel and seed by-products and their use as a source of carotenoids. J. Sci. Food Agric. 85:1166-1170.

Meilgaard, M. C., G.V. Civille, and B.T. Carr (2007). Overall Difference Tests: Does a Sensory difference Exist Between Samples? In: Sensory Evaluation Techniques 4thed. C.R.C. Press L.L.C. New York. USA. 63-104.

Mujtaba, A. and T. Masud (2014). Enhancing post harvest storage life of tomato (*Lycopersicon esculentum* Mill.) cv. rio grandi using calcium chloride. American-Eurasian J. Agric. Environ. Sci. 14(2):143-149.

Mushtaq, Z., T. Zahoor, S. Rehman, and A. Jamil (2010). Impact of xylitol replacement on physicochemical, sensory and microbial quality of cookies. Pakistan J. Nutr. 9:605-610.

Masih, S., Z. Iqbal, A. M. Arif, M. Rafiq, G. Rasool, and A. Rashid (2014). Effect of linseed oil substitution on physico-chemical properties of cookies. J. Agric. Res. 52(3):425-437.

Noorolahi, Z., M. A. Sahari, M. Barzegar, N. Doraki, and N. H. Badi (2012). Evaluation Antioxidant and Antimicrobial Effects of Cinnamon Essential Oil and Echinacea Extract in Kolompe. J. Med. Plants. 1(45):14-28.

Nasir, M. U., S. Hussain, and S. Jabbar (2015). Tomato processing, lycopene and health benefits: A review. Sci Lett. 3(1):1-5.

Pasha, I., M.S. Butt, F.M. Anjum, and N. Shehzadi (2002). Effect of dietetic sweeteners on the quality of cookies. Int. J. Agri. Biol. 4:245-248.

Piga, A., P. Cdatzedu, S. Farris, T. Roggio, and E. Scano (2005). Textural evaluation of amaretti cookies during storage. Food Res. Technol. 221:387-391.

Rehman, S., M. Nadeem, F. Ahmad, and Z. Mushtaq (2013). Biotechnological production of xylitol from banana peel and its impact on physicochemical properties of rusks. J. Agr. Sci. Tech.15:747-756.

Rizk, E. M., A.T. El-Kady, and A. R. El-Bialy (2014). Characterization of carotenoids (lyco-red) extracted from tomato peels and its uses as natural colorants and antioxidants of ice cream. Ann. of Agri. Sci. 59(1):53-61.

Sharif, K., M. S. Butt, and N. Huma (2005). Oil extraction from rice industrial waste and its effect on physico-chemical characteristics of cookies. J. Nutr. Food Sci. 35:416-427.

Sogi, D. S., J. S. Sidhu, M.S. Arora, S. K. Garg, and A. S. Bawa (2002). Effect of tomato seed supplementation on the dough and bread characteristics of wheat flour (PBW 343). Inter. J. Food Proper. 5(3):563-571.

Srivastava, P., D. Indrani, and R. P. Singh (2014). Effect of dried pomegranate (*Punica granatum*) peel powder (DPPP) on textural, organoleptic and nutritional characteristics of biscuits. Int. J. Food Sci. Nutr. 65(7):827-833.

Stajcic, S., G. Cetkovic, J. Canadanovic-Brunet, S. Djilas, A. Mandic, and D. Cetojevic-Simin (2015). Tomato waste: carotenoids content, antioxidant and cell growth activities. Food Chem. 172: 225-232.

Steel, R. G. D., J. H. Torrie, and D. Dickey (1997). Principles and Procedures of Statistics. A biometrical approach.3rd Ed. McGraw Hill Book Co Inc. New York. 266-267.

Turksoy, S. and B. Ozkaya (2011). Pumpkin and carrot pomace powders as a source of dietary fiber and their effects on the mixing properties of wheat flour dough and cookie quality. Food Sci. Technol. Res. 17(6):545-553.

Toor, R. K. and G.P. Savage (2005). Antioxidant activity in different fractions of tomatoes. Food Res. Int. 38:487-494.

Valle, M. D., M. Camara, and M. E. Torija (2006). Chemical characterization of tomato pomace. J. Sci. Food Agric. 86(8):1232-1236.

Vagi, E., B. Simandi, K. P. V. Vasarhelyin, H. Daood, A. Kery, L. F. Doleschal, and B. Nagy (2007). Supercritical carbon dioxide extraction of carotenoids, tocopherols and sitosterols from industrial tomato by-products. J. Supercrit Fluids. 40:218-226.