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Quality and antioxidant properties of wheat cookies supplemented with pak choi powder

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Abstract

The replacing effect of pak choi powder (PCP) on the quality characteristics and antioxidant activities of wheat cookies was investigated in order to develop functionally and nutritionally improved food. The incorporation of PCP to wheat flour significantly affected the physicochemical properties of the cookie dough and cookies. Increased levels of incorporation remarkably increased the density of the cookie dough and the hardness of the cookies but decreased the cookie spread and loss rate. The L* and b* color values of the cookie surface significantly decreased while the a* value increased as a result of increase of PCP substitution ($p<0.05$). The 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS) radical scavenging activities significantly increased ($p<0.05$) with increase of PCP substitution in a well-correlated manner. Hedonic sensory testing revealed that cookies supplemented with 2% PCP received satisfactory and acceptable preference scores. Overall, cookies with acceptable physical characteristics and superior antioxidant activities can be produced by partially replacing wheat flour with 2% PCP.

Key words : pak choi powder, wheat cookie, physicochemical properties, consumer acceptance, antioxidant properties

Introduction

Brassica vegetables belong to the Cruciferae family and include cabbage, broccoli, cauliflower, kale, and pak choi (Jacob et al., 2011). The high and regular intake of Brassica vegetables reduces the risk of cardiovascular and other degenerative diseases (Kris-Etherton et al., 2002) and several types of cancer (Verkerk et al., 2009). The contribution of Brassica vegetables to health-promoting effect is partly associated with their antioxidant, anti-inflammatory, and anticancer activities, and is ascribable to a variety of structurally different secondary plant metabolites (Francisco et al., 2017).

Pak choi, a non-head Chinese cabbage, also known as bok choy, is an important leafy vegetable cultivated and consumed worldwide for its edible leaves (Wu et al., 2019) and is rapidly gaining popularity in the European market due to its pleasant natural taste (Wang et al., 2007). It has a light and sweet flavor, crisp texture, and contains high amounts of minerals (Ca, K, and Na) and vitamins (B_2, C, and A) (Lu, 2007). Pak choi is traditionally heavily consumed in eastern and southern China (Wang et al., 2007) and is among the leading vegetables consumed by Chinese people, accounting for 30-40% of the vegetable-production area in China (Hanson et al., 2009). Nevertheless, the worldwide consumption of vegetables remains below the recommended levels in many countries (Vale et al., 2015).

Bakery products such as cookies are widely accepted and consumed worldwide, especially in many developing countries. Hence, adding Brassica vegetable powder to

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cookies may be a promising and health-promoting strategy for increasing the consumption of healthy food ingredients in a convenient diet (Klopsch et al., 2019). Cookies are a valuable supplementation vehicle for nutritional improvement (Zucco et al., 2011) and can easily serve as a good source of energy and refreshment in the form of a ready-to-eat convenience food (Park et al., 2017; Tae et al., 2015).

Rapidly growing concerns about healthy diets have led to studies on wheat-based products supplemented with new natural value-added food ingredients. Cookies with these characteristics have been produced from blends of wheat and powders of chlorella (Bang et al., 2013), jujube (Kim et al., 2014), purple kohlrabi (Cha et al., 2014), acaiberry (Choi et al, 2014), *Spergularia marina* (Son et al., 2015), burdock (Lee, 2017), *Takju* pomace (Im et al., 2017), *Lentinus edodes* (Kim and Chung, 2017) and young persimmon fruit (Seong et al., 2017), to name a few. However, there appears to be no information on the use of pak choi in cookie-making. Hence, in this study, we assessed the suitability of using pak choi powder (PCP) for improving the quality and antioxidant properties of cookies.

Materials and methods

Materials

PCP was procured from Heungyildang (Seoul, Korea), and wheat flour (soft flour, CJ Cheiljedang, Yangsan, Korea), white sugar (CJ Cheiljedang, Seoul, Korea), salt-free butter (Namyang Co., Cheonan, Korea), and eggs were purchased from a local market.

Cookie formulation and preparation

The standard cookie recipe uses 200 g (100%) of flour (white wheat flour as a control), 90 g of salt-free butter, 100 g of white granulated sugar, and 50 g of eggs. Composite-flour cookies were prepared using various combinations of wheat flour and PCP in ratio of 100:0, 98:2, 96:4, 94:6, and 92:8. Butter, sugar, and eggs were creamed with a kitchen mixer (5K5SS, KitchenAid Inc., St. Joseph, MI, USA) at speed 2 for 3 min, with scraping down every minute. Wheat flour and the appropriate amount of PCP were then added and mixed at speed 2 for 3 min. The dough was placed in a 4℃ refrigerator for 30 min before sheeting. The cookies were prepared by slightly flattening the dough with the palm of the hand, sheeting with a roller to a uniform thickness of 4 mm, and cutting into 5 cm-diameter circular shapes. The dough pieces were then placed on a baking tray with baking paper and baked at 170℃ for 10 min in a preheated oven (KXS-4G+H, Salvia industrial S.A., Lezo, Spain). The baked cookies were removed from the oven and cooled for 1 h, weighed, packed in sealed plastic bags, and stored for 24 h at ambient temperature prior to analysis. Test cookie samples prepared with wheat flour substituted with 0, 2, 4, 6, and 8% PCP are designated as control, PCP2, PCP4, PCP6, and PCP8, respectively.

Physicochemical analyses of cookie dough and cookies

A dough sample (5 g) was mixed with 45 mL of distilled water and vortexed for 1 min. The mixture was held at ambient temperature for 1 h in order to separate the solid and liquid phases. The pH of the supernatant was measured using a pH meter (pH/Ion 510, Oakton Instruments, Vernon Hills, IL, USA). The dough density was measured in a 50 mL graduated cylinder by water displacement (Kim and Chung, 2017; Lee et al., 2017). The moisture content of the cookie dough was determined by drying a specific amount (5 g) of sample to a constant weight at 105℃ in an oven (FOL-2, Jeio Tech Co., Daejeon, Korea), and the results were reported on a wet basis (*w*%).

The cookie spread factor was determined according to the AACC Method 10-50D (AACC, 2000). Diameters were measured with a Vernier caliper by laying down six cookies edge to edge. The diameters of the six cookies were re-measured after rotating each cookie by 90°, after which the average cookie diameter was calculated. Six cookies were stacked on top of each other and the total thickness was measured. The cookies were restacked in random order and the total thickness was re-measured, after which the average cookie thickness was calculated. The cookie spread factor was calculated by dividing the average cookie diameter by the average cookie thickness. The loss rate is expressed as the percent weight ratio before and after the cookie had been baked.

The hardness of the baked cookie was measured using a texture analyzer (LRX*Plus*, Lloyd Instrument Limited, Fareham, Hampshire, UK) in the compression mode using a three-point bending test in a three-point bending rig with a trigger force of 0.05 N and load cell of 100 N. Textural studies were conducted at a test speed of 1.0 mm/s and a distance of 10 mm, with the distance between the two bottom supports was adjusted to 40 mm. The peak fracture force (maximum) required to break a cookie into two major pieces was recorded as the hardness (Chakraborty et al., 2009). The peak force required to snap a cookie was recored as the fracture force (N). The surface colors of the PCP cookies were measured on the basis of the CIE L*, a*, and b* color system using a chromameter (CM-600d, Minolta Co., Osaka, Japan).

Determining free radical scavenging activities

The 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activities of the samples were determined in terms of their hydrogen donating or radical scavenging activities using the stable DPPH radical as previously described by Blois (Blois, 1958) with some modifications. Briefly, a 0.15 mM solution of DPPH in ethanol was prepared, after which 5 mL of this solution was added to 1 mL aliquots of sample mixtures in ethanol at various concentrations, shaken, and then left to stand for 10 min. Decolorization of DPPH-donated protons was determined by measuring the absorbance at 517 nm using a spectrophotometer (Optizen 2020 UV Plus, Mecasys Co., Ltd., Daejeon, Korea). The scavenging activity of the DPPH radical was calculated using the following equation:

$$\text{Radical scavenging activity (\%)} = [(Abs._{\text{control}} - Abs._{\text{sample}})/Abs._{\text{control}}] \times 100$$

The $ABTS^{+\cdot}$ radical scavenging activity was spectrophotometrically determined according to the method used of Re et al. (1999) with slight modification. The $ABTS^{+\cdot}$ cation radical was produced by the reaction between 7.4 mM 2,2'-azino-bis-3-ethylbenzthiazoline-6-sulfonic acid (ABTS) in H_2O and 2.6 mM potassium persulfate when stored in the dark at room temperature for 12 h. Before use, the $ABTS^{+\cdot}$ solution was diluted with methanol to obtain an absorbance of 1.1 at 734 nm. Subsequently, 3 mL of $ABTS^{+\cdot}$ solution was added to 0.1 mL of a sample mixture. After 10 min, the percent inhibition at 734 nm was calculated for each concentration relative to the absorbance of the blank.

Sensory evaluation

The cookies were subjected to sensory evaluation by thirty-five untrained volunteer panelists (15 males and 20 females, aged between 21 and 27), drawn from the university community. The cookies were evaluated for consumer acceptance of color, flavor, softness, taste, and overall acceptance. The ratings used a nine-point Hedonic scale ranging from 9- (extremely like) to 1- (extremely dislike). The serving order was completely random. The overall acceptance was evaluated first, and another session was held to evaluate the remaining attributes. An inter-stimulus interval of 30 sec was imposed between samples to allow time to recover from adaptation. Participants were advised to rinse their palates between samples. Enough space was provided for handling the samples and completing the questionnaire, and the evaluation time was unconstrained. No specific compensation was provided to the participants. This study was approved by the Daegu University Institutional Review Board (IRB # 1040621-201703-HR-013-02).

Statistical analysis

Each experiment was conducted in triplicate, except for the moisture content (n=6), color (n=9), hardness (n=15), and sensory evaluations (n=35). The experimental data were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure to identify significant differences among the samples. Mean values were compared using Duncan's multiple range test. The significance was defined at the 5% level.

Results and discussion

Physicochemical characteristics of cookie dough

Table 1 lists the physicochemical data for the cookie dough supplemented with various amounts of PCP. The pH of the dough ranged between 6.44 and 6.71 (range=0.27) and decreased significantly upon the addition of PCP ($p<0.05$); nevertheless, only minor changes were observed. Therefore, it seems that PCP supplementation produces cookies of slightly lower pH than regular cookies. Similar reduction in pH were observed for cookie doughs incorporated with *Hovenia dulcis* fruit powder (Park et al., 2017) and burdock powder (Lee, 2017), which is probably due to the weakly acidic nature of the powder supplemented; the pH of PCP

Table 1. Physicochemical characteristics of cookie dough containing different levels of PCP

Sample	Properties		
	pH	Density (g/mL)	Moisture content (*w*%)
0%	6.71±0.01[a1)]	1.03±0.01[c]	16.60±0.11[a]
2%	6.68±0.01[b]	1.17±0.06[b]	16.54±0.41[a]
4%	6.56±0.01[c]	1.20±0.08[ab]	16.30±0.02[a]
6%	6.46±0.01[d]	1.24±0.02[ab]	16.28±0.15[a]
8%	6.44±0.01[e]	1.27±0.05[a]	16.25±0.42[a]

[1)]Means within the same row without a common letter ([a-e]) are significantly different ($p<0.05$).

was determined to be 6.26 in this study.

The cookie dough appeared to become denser upon addition of PCP; however, no significant differences were found among the PCP2, PCP4, and PCP6 samples, as well as the PCP4, PCP6, and PCP8 samples ($p>0.05$); only the control was significantly less dense than the others ($p<0.05$). This is attributable to interactions between the cellulose within PCP and wheat flour protein (Seong et al., 2017). Other researchers have also reported similar increases when *Lentinus edodes* powder (Kim and Chung, 2017) and pine needle powder (Choi, 2009) were incorporated, with density values of 1.11-1.16 and 1.00-1.24, respectively.

The moisture content of the cookie dough ranged from 16.25 to 16.60% and appeared to decrease slightly when PCP was added, but no significant differences were found among the groups ($p>0.05$). The lower moisture content can be explained by the affinity of PCP for moisture (Lim et al., 2003); however the effect was not significant.

Physicochemical characteristics of cookies

Table 2 lists the physicochemical data for cookies supplemented with various amounts of PCP. Cookie spread is an indicator of how the dough is pushed outward during baking, which results in thinner cookes with larger diameter. The spread factor is widely used as an indicator of cookie quality and is a relatively complex parameter that is influenced by a wide variety of factors (Pareyt et al., 2009), including the type of flour and its absorption, the type of added fat and sugar, the kneading method and time, and the baking temperature and the time, among others (Koh and Noh, 1997).

The spread factor decreased from 9.32 to 8.79 with increasing levels of white wheat flour substitution. The contorl and PCP8 samples exhibited significantly different values ($p<0.05$), while no significant differences were found among the control, PCP2, PCP4, and PCP6 samples, as well as the PCP2, PCP4, PCP6, and PCP8 samples ($p>0.05$).

The lower cookie spread factors are attributable to the fact that composite flours of wheat and PCP apparently appregate with increasing number of hydrophilic sites that compete for the limited free water in the cookie dough (McWatters, 1978), which increases the dough viscosity and limits cookies spread (Agrahar-Murugkar et al., 2015). In addition, sugar and different sugar types affect the cookie geometry, which in turn contribute to cookie spread (Kweon et al., 2009), while gluten influences the diameter and spread onset time, which is also dependent on the amount of free water available to the non-gluten constituents (Pareyt

Table 2. Physicochemical characteristics of cookies containing different levels of PCP

Sample	Properties					
	Spread factor	Loss rate (%)	Hardness (N)	Color		
				L*	a*	b*
0%	9.32±0.12[a1)]	15.74±0.44[a]	18.20±2.22[e]	61.40±0.58[a]	6.64±0.36[d]	31.48±0.49[a]
2%	9.14±0.26[ab]	15.30±0.24[a]	23.99±2.64[d]	52.52±0.49[b]	7.81±0.49[c]	31.14±0.57[a]
4%	9.11±0.28[ab]	15.12±0.27[a]	27.51±4.35[c]	49.21±0.58[c]	8.19±0.70[bc]	29.89±0.62[b]
6%	8.97±0.15[ab]	14.39±0.10[a]	30.24±4.06[b]	43.42±0.73[d]	8.35±0.68[ab]	26.95±0.68[c]
8%	8.79±0.07[b]	14.15±0.25[a]	33.22±3.12[a]	40.44±0.69[e]	8.81±0.35[a]	25.22±0.66[d]

[1)]Means within the same row without a common letter ([a-e]) are significantly different ($p<0.05$).

et al., 2008). Structural variations in flour help to absorb more water. However, the water in the PCP cookie formulation is already limited; as a result, the dough remained harder and a lower spread ratio was observed for the PCP-substituted cookies. Similar decreasing trends with respect to the level of ingredient substitution were reported for cookies made from powers of 0-20% jujube (Kim et al., 2014), 0-5% purple kohlrabi (Cha et al., 2014), 0-8% acaiberry (Choi et al., 2014), 0-9% *Spergularia marina* (Son et al., 2015), 0-70% yam (Suriya et al., 2017), and 0-50% pearl millet (Kulthe et al., 2017).

The loss rate appeared to generally decrease with increasing amounts of added PCP in the cookie formulation; however, no significant differences were observed among the samples ($p>0.05$), which is due to the fact that PCP was introduced into the recipe, which prevents moisture loss during baking process through physicochemical interaction between PCP and the cookie dough that causes bound water to form.

The cookies containing PCP were significantly ($p<0.05$) harder than the control. Increasing levels of PCP were observed to remarkably increase the cookie hardness, from 18.20 N at 0% PCP to 33.22 N at 8% of substitution. The hardness values of the PCP cookies were found to be in the range of values reported by others (Lee, 2017; Park et al., 2017). The higher amount of gluten formed due to the lower water content caused by the high water-holding capacity of PCP (Kim et al., 2014) might explain the increasing hardness values of the PCP-substituted cookies. Similar observations have been reported for cookies incorporated with jujube (Kim et al, 2014), purple kohlrabi (Cha et al., 2014), *Spergularia marina* (Son et al., 2015), and *Codonopsis lanceolata* (Song and Lee, 2014) powders.

All color data were expressed as CIELAB L*, a*, and b* values that correspond to lightness, redness, and yellowness, respectively. The L* value of the control sample was the highest (61.40), while that of the PCP8 sample was the lowest (40.44); these values were found to be significantly different ($p<0.05$). The cookies became darker in color with increasing levels of PCP substitution, as evidenced by decreasing L* values. The addition of PCP resulted in increases in the redness (a*) but decreases in the yellowness (b*) compared to those of the control, which is attributable to the distinctive color changes brought about by the PCP replacing wheat flour at different levels. These results are in accordance with the findings reported for cookies supplemented with *Hovenia dulcis* fruit powder (Park et al., 2017), acorn powder (Joo et al., 2013), and sesame peels flour (Zouari et al., 2016). The surface color generated during baking process is probably due to Maillard reactions between reducing sugars and amino acids (Chevallier et al., 2000), while the dextrinization of starch and sugar caramelization, which are induced by heating, also affects the color formed in cookies during baking (Chung et al., 2014).

Free radical scavenging activities

Antioxidant compounds are known to prevent, delay or retard the development of rancidity or other flavor deterioration in foods; they are also capable of protecting the human body against oxidative damage (Jan et al., 2016). The PCP-supplemented cookies exhibited higher antioxidant activities compared to the whole wheat flour cookies ($p<0.05$) (Fig. 1). The use of PCP in the cookie formulation clearly enhances antioxidant activity, with antioxidant effectiveness ascending in the following order: control < PCP2 < PCP4 < PCP6 < PCP8. The highest DPPH and ABTS activities were exhibited by cookies containing 8% PCP, with values of 25.80% and 8.23%, respectively. These results show that PCP supplementation greatly enhances the antioxidant properties of the cookies, which is due to the incorporation of phenolic compounds that are known to

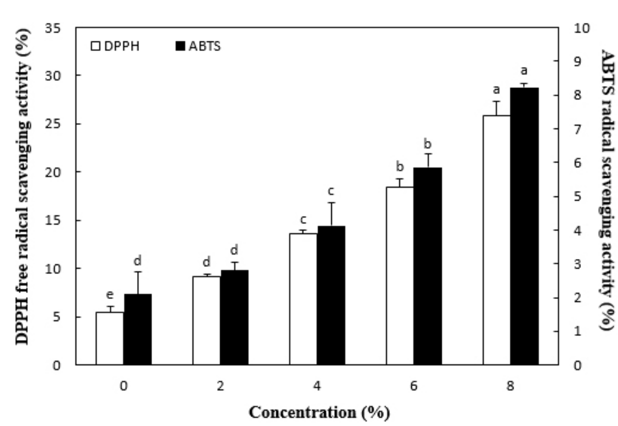

Fig. 1. DPPH and ABTS radical scavenging activities of cookies with different levels of PCP.

Means with in the same activity without a common letter ([a-e]) are significantly different ($p<0.05$).

exhibit antioxidant activities (Francisco et al., 2017). ABTS also showed a similar increasing trend with increasing amount of PCP substitution. Cookies supplemented with *Hovenia dulcis* fruit (Park et al., 2017) and burdock (Lee, 2017) powders showed similarly improved antioxidant activities. Baking has also been reported to increase the antioxidant activities of cookies (Chauhan et al., 2015) due to the dark-brown pigments formed during baking that have been reported to provide antioxidant properties (Zilic et al., 2016).

Sensory characteristics of cookies

Incorporating PCP in wheat flour was found to significantly influence all the sensory characteristics evaluated for the cookies ($p<0.05$) (Table 3). The highest softness and taste scores were given to cookies prepared from the blend containing 2% PCP, whose scores were not significantly different from those of the control ($p>0.05$). However, the addition of further PCP significantly lowered both scores. Although PCP2 did not achieve the highest scores in terms of preferred color and flavor, its values were close to those of the control and significantly higher than those of PCP4, PCP6, and PCP8 ($p<0.05$). In general, the preference scores continued to decrease with increasing levels of PCP substitution especially at levels above 2%. The control received the highest overall preference scores, with the scores for PCP2 not significantly different ($p>0.05$); however, PCP incorporation above 2% significantly lowered the scores ($p<0.05$). On a nine-point hedonic scale, PCP2 received scores over 6, except for flavor (5.86), which is very acceptable. The data showed that the PCP cookies exhibited the highest sensory quality at a PCP level of 2%. On the basis of these results, we conclude that the partial replacement of wheat flour with 2% PCP in the cookie formulation provides a satisfactory outcome. Chung and Kim (2009) reported that PCP can be incorporated in sponge cake as a partial replacement for wheat flour to levels up to 3% without negatively affecting its physical and sensory qualitis.

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Conflict of interests

The authors declare no potential conflict of interest.

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References

AACC. Approved Methods of the AACC (10-50D). 10th ed, American Association of Cereal Chemists, St Paul, MN, USA, p 1-6 (2000)

Agrahar-Murugkar D, Gulati P, Kotwaliwale N, Gupta C. Evaluation of nutritional, textural and particle size characteristics of dough and biscuits made from composite flours containing sprouted and malted ingredients. J Food Sci Technol, 52, 5129-5137 (2015)

Bang BH, Kim KP, Jeong EJ. Quality characteristics of

Table 3. Consumer preference of cookies containing different levels of PCP

Sample	Attribute				
	Color	Flavor	Softness	Taste	Overall preference
0%	7.77±1.14[a]	7.09±1.38[a]	6.31±1.55[a]	6.83±1.25[a]	7.00±1.33[a]
2%	6.43±1.50[b]	5.86±1.82[b]	6.00±1.77[a]	6.20±1.71[a]	6.66±1.55[a]
4%	4.66±1.71[c]	4.80±1.78[c]	4.31±1.78[b]	5.29±1.86[b]	5.34±1.75[b]
6%	3.94±1.61[c]	3.57±1.29[d]	4.06±1.73[b]	3.71±1.49[c]	3.91±1.34[c]
8%	2.83±1.81[d]	3.49±1.96[d]	3.69±2.37[b]	3.20±2.01[c]	3.03±1.69[d]

[1)]Means within the same row without a common letter ([a-d]) are significantly different ($p<0.05$).

cookies that contain different amounts of chlorella powder. Korean J Food Preserv, 20, 798-804 (2013)

Blois MS. Antioxidant determinations by the use of a stable free radical. Nature, 181, 1199-1200 (1958)

Cha SS, Jung HO, Son HK, Lee JJ. Physicochemical and sensory characteristics of cookies with added purple kohlrabi powder. Korean J Food Preserv, 21, 824-830 (2014)

Chakraborty SK, Singh DS, Kumbhar BK, Singh D. Process parameter optimization for textural properties of ready-to-eat extruded snack food from millet and legume pieces. J Texture Stud, 40, 710-726 (2009)

Chauhan A, Saxena DC, Singh S. Total dietary fibre and antioxidant activity of gluten free cookies made from raw and germinated amaranth (*Amaranthus* spp.) flour. LWT - Food Sci Technol, 63, 939-945 (2015)

Chevallier S, Colonna P, Valle GD, Lourdin D. Contribution of major ingredients during baking of biscuit dough systems. J Cereal Sci, 31, 241-252 (2000)

Choi HY. Antioxidant activity and quality characteristics of pine needle cookies. J Korean Soc Food Sci Nutr, 38, 1414-1421 (2009)

Choi YS, Kim SK, Mo EK. Quality characteristics of cookies with acaiberry (*Euterpe oleracea* Mart.) powder added. Korean J Food Preserv, 21, 661-667 (2014)

Chung HJ, Cho A, Lim ST. Utilization of germinated and heat-moisture treated brown rices in sugar-snap cookies. LWT - Food Sci Technol, 57, 260-266 (2014)

Chung YS, Kim DJ. Quality characteristics of sponge cake with pakchoi (*Brassica compestris* L. spp. *chinensis* Jusl.) powder. J Korean Soc Food Sci Nutr, 38, 914-919 (2009)

Francisco M, Tortosa M, Martinez-Ballesta MC, Velasco P, Gracia-Viguera C, Moreno DA. Nutritional and phytochemical value of *Brassica* crops from the agri-food perspective. Ann Appl Biol, 170, 273-285 (2017)

Hanson P, Yang RY, Chang LC, Ledesma L, Ledesma D. Contents of carotenoids, ascorbic acid, minerals and total glucosinolates in leafy *Brassica* pakchoi (*Brassica rapa*, L. *chinensis*) as affected by season and variety. J Sci Food Agric, 89, 906-914 (2009)

Im CY, Kim MH, Kang WW. Quality characteristics of cookies added with Takju pomace powder. Korean J Food Preserv, 24, 8-12 (2017)

Jacob JA, Mahal HS, Mukherjee T, Kapoor S. Free radical reactions with the extract of brassica family. Food Chem, 129, 1132-1138 (2011)

Jan R, Saxena DC, Singh S. Physico-chemical, textural, sensory and antioxidant characteristics of gluten-free cookies made from raw and germinated Chenopodium (*Chenopodium album*) flour. LWT - Food Sci Technol, 71, 281-287 (2016)

Joo SY, Kim OS, Jeon HK, Choi HY. Antioxidant activity and quality characteristics of cookies prepared with acorn (*Quercus species*) powder. Korean J Food Cookery Sci, 29, 177-184 (2013)

Kim MJ, Choi JE, Lee JH. Quality characteristics of cookies added with jujube powder. Korean J Food Preserv, 21, 146-150 (2014)

Kim MJ, Chung HJ. Quality characteristics and antioxidant activities of rice cookies added with *Lentinus edodes* powder. Korean J Food Preserv, 24, 421-430 (2017)

Klopsch R, Baldermann S, Hanschen FS, Voss A, Rohn S, Schreiner M, Neugart S. *Brassica*-enriched wheat bread: Unraveling the impact of ontogeny and breadmaking on bioactive secondary plant metabolites of pak choi and kale. Food Chem, 295, 412-422 (2019)

Koh WB, Noh WS. Effect of sugar particle size and level on cookie spread. J East Asian Dietary Life, 7, 159-165 (1997)

Kris-Etherton PM, Hecker KD, Bonanome A, Coval SM, Binkoski AE, Hilpert KF, Griel AE, Etherton TD. Bioactive compounds in foods: Their role in the prevention of cardiovascular disease and cancer. Am J Med, 113, 71-88 (2002)

Kulthe AA, Thorat SS, Lande SB. Evaluation of physical and textural properties of cookies prepared from pearl millet flour. Int J Curr Microbiol App Sci, 6, 692-701 (2017)

Kweon M, Slade L, Levine H, Martin R, Souza E. Exploration of sugar functionality in sugar-snap and wire-cut cookie baking: Implications for potential sucrose replacement or reduction. Cereal Chem, 86, 425-433 (2009)

Lee JH. Physicochemical and sensory evaluation of wheat cookies supplemented with burdock powder. Korean J Food Preserv, 24, 1053-1059 (2017)

Lee YM, Shin HS, Lee JH. Quality characteristics and antioxidant properties of cookies supplemented with *Taraxacum coreanum* powder. J Korean Soc Food Sci Nutr, 46, 273-278 (2017)

Lim YS, Cha WJ, Lee SK, Kim YJ. Quality characteristics of wet noodles with *Lycii fructus* powder. Korean J Food Sci Technol, 35, 77-83 (2003)

Lu S. Effect of packaging on shelf-life of minimally processed Bok Choy (*Brassica chinensis* L.). LWT - Food Sci Technol, 40, 460-464 (2007)

McWatters KH. Cookie baking properties of defatted peanut, soybean, and field pea flours. Cereal Chem, 55, 853-863 (1978)

Pareyt B, Talhaoui F, Kerckhofs G, Brijs K, Goesaert H, Wevers M, Delcour JA. The role of sugar and fat in sugar-snap cookies: Structural and textural properties. J Food Eng, 90, 400-408 (2009)

Pareyt B, Wilderjans E, Goesaert H, Brijs K, Delcour JA. The role of gluten in a sugar-snap cookie system: A model approach based on gluten-starch blends. J Cereal Sci, 48, 863-869 (2008)

Park BR, Choi JE, Lee JH. Effect of dried *Hovenia dulcis* fruit powder on quality characteristics and antioxidant properties of cookies. Korean J Food Preserv, 24, 517-523 (2017)

Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radical Biol Med, 26, 1231-1237 (1999)

Seong JH, Park HS, Chung HS, Kim DS, Kim HS, Lee YG. Effects of young persimmon fruit powder on rice cookie quality. Korean J Food Preserv, 24, 1060-1066 (2017)

Son HK, Kong HM, Cha SS, Choi YJ, Lee JJ. Quality characteristics of cookies added with *Spergularia marina* Griseb powder. Korean J Food Preserv, 22, 211-217 (2015)

Song JH, Lee JH. The quality and antioxidant properties of cookies containing *Codonopsis lanceolata* powder. Korean J Food Sci Technol, 46, 51-55 (2014)

Suriya M, Rajput R, Reddy CK, Haripriya S, Bashir M. Functional and physicochemical characteristics of cookies prepared from *Amorphophallus paeoniifolius* flour. J Food Sci Technol, 54, 2156-2165 (2017)

Tae MH, Kim KH, Yook HS. Quality characteristics of bread with burdock (*Arctium lappa* L.) powder. J Korean Soc Food Sci Nutr, 44, 1826-1831 (2015)

Vale AP, Santos J, Brito NV, Peixoto V, Carvalho R, Rosa E, Oliveira MBPP. Light influence in the nutritional composition of *Brassica oleracea* sprouts. Food Chem, 178, 292-300 (2015)

Verkerk R, Schreiner M, Krumbein A, Ciska E, Holst B, Rowland I, De Schrijver R, Hansen M, Gerhauser C, Mithen R, Dekker M. Glucosinolates in Brassica vegetables: The influence of the food supply chain on intake, bioavailability and human health. Mol Nutr Food Res, 53, S219 (2009)

Wang HJ, Wu LH, Wang MY, Zhu YH, Tao QN, Zhang FS. Effects of amino acids replacing nitrate on growth, nitrate accumulation, and macroelement concentrations in pak-choi (*Brassica chinensis* L.). Pedosphere, 17, 595-600 (2007)

Wu W, Gao H, Chen H, Fang X, Han Q, Zhong Q. Combined effects of aqueous chlorine dioxide and ultrasonic treatments on shelf-life and nutritional quality of bok choy (*Brassica chinensis*). LWT - Food Sci Technol, 101, 757-763 (2019)

Zilic S, Kocadagli T, Vancetovic J, Gokmen V. Effects of baking conditions and dough formulations on phenolic compound stability, antioxidant capacity and color of cookies made from anthocyanin-rich corn flour. LWT - Food Sci Technol, 65, 597-603 (2016)

Zouari R, Besbes S, Ellouze-Chaabouni S, Ghribi-Aydi D. Cookies from composite wheat-sesame peels flours: Dough quality and effect of *Bacillus subtilis* SPB1 biosurfactant addition. Food Chem, 194, 758-769 (2016)

Zucco F, Borsuk Y, Arntfield SD. Physical and nutritional evaluation of wheat cookies supplemented with pulse flours of different particle sizes. LWT - Food Sci Technol, 44, 2070-2076 (2011)