Culinary Science & Hospitality Research. 2017;23(1):28-36.
DOI: 10.20878/cshr.2017.23.1.004

The Quality Characteristics of Macaroon added with *Helianthus tuberosus* L. Powder

Young-Sim Choi†
Dept. of Food & Culinary Arts, Suwon Women's University

ABSTRACT

This study made macaroon with the addition of *Helianthus tuberosus* L. powder so as to increase the application of *Helianthus tuberosus* L. powder (HTP) to food products and look into the quality characteristics depending on an addition ratio. *Helianthus tuberosus* L. powder 0%, 0.5%, 1.0%, 1.5%, and 2.0% were added, respectively, to make macaroon. As *Helianthus tuberosus* L. powder was added more, the moisture content tended to decrease more significantly (p<0.001). As *Helianthus tuberosus* L. powder was added more, lightness and yellowness tended to reduce more significantly (p<0.001). As *Helianthus tuberosus* L. powder was added more, the content of total phenol compounds and DPPH radical scavenging activity were significantly increased (p<0.001). In terms of texture analysis, hardness, gumminess, cohesiveness and chewiness were significantly increased, as the *Helianthus tuberosus* L. powder was increased (p<0.05). In terms of sensory test, regarding taste, 0.5% HTP group had the highest points. And as color, flavor, and texture were improved, 1.5% HTP showed the most desirable result in terms of overall acceptability. Results, if *Helianthus tuberosus* L. powder is added for cooking macaroon, it seems to increase anti-oxidation function and develop functional macaroon with excellent sensory factors.

Keywords: *Helianthus tuberosus* L., macaroon, quality characteristics, texture, sensory, overall acceptability

INTRODUCTION

With the economic growth and the change in the pattern of dietary life, adult disease has emerged as a social issue. In the circumstances, the demands for the food products with health functionality are on the rise, and relevant research is conducted in diversified ways (Choi, & Lee, 2009; Kim, Oh, Kim, & Kim, 1996; Park, 2010). In addition, the development of a new product with functional ingredients in line with the taste of today's people has become a critical factor of purchase (Kim, & Jeong, 2006; Park, An, & Ryu, 2013).

Helianthus tuberosus L. is a perennial plant belonging to the same Asteraceae family, growing in the world. It is possible to cultivate a large volume of the plant in a barren land at a low price, so that the plant is known to contribute to a high income (Jung, 2015). A tuber of *Helianthus tuberosus* L. has been used to control blood sugar and treat rheumarthritis and osteoporosis (Hwang, Lee, Jang, & Kim, 2015). The main substance *inulin* is helpful in reducing neutral lip, controlling blood cholesterol, improving constipation, enhancing blood sugar, and improving enteropathy and obesity, and recently is reported to help to prevent cancer (Jung, 2015; Kim, Yu, Yoon, Jang, Jang, & Lee, 2014: Kim, Lee, & Kim, 2014; Park, 2014; Park et al., 2013). In addition, the plant help to increase fiber intake and improve health so that it is helpful to develop a well-being food product (Kim et al., 2013). However, because it lacks gluten, it is necessary to improve a product in flour process (Kim, 2015; Kim et al., 2013; Shin, Byun, Noh, Choi, 1991).

Recently, research on *Helianthus tuberosus* L. was conducted by antioxidant (Kim, Lee, Hwang, Kim, Park, & Jeon, 2011) and by Skin-Whitening Efficacy (Hwang et al., 2015). *Mook* (Kim, 2015), rice dumpling shell (Jung, 2015), noodle (Shin et al., 1991), rice sponge cakes (Kim et al., 2014), *sulgidduk* (Park, 2010), cookies (Park & Ryu, 2013), *buchimgaru* (Kim et al., 2013), sponge cakes (Suh & Kim, 2014), muffin (Park, 2014), and *jochung* (Lee, 2015) have researched the food products relating to the plant. But, research on macaroon of

† **Corresponding author:** Young-Sim Choi, Dept. of Food & Culinary Arts, Suwon Women's University, 1098, Juseok-ro, Bongdam-eup, Hwasung-si, Gyeonggi-do, 18333, Korea, Tel. +82-31-290-8966, Fax. +82-31-290-8924, E-mail. yschoi@swc.ac.kr

the plant has yet to be conducted.

Helianthus tuberosus L. was produced in a way that the egg white, sugar and nut are mixed and squeezed out by the petit four sec before baked. It is the round cookie with 3 inch tall and 2 inch in diameter. The information on *Helianthus tuberosus* L. was informed to France by a chef who was brought to France when Princess Catrin of Medici Family married Henry the Second of France. Afterwards, it was spread over each corner of France. In 17th century, the name of macaroon used in the monastery located in Nancy, Lorraine was spread over the France. Since late 18th century, macaroon has been produced in the same shape as today (Peam, 2013).

With the recent change of advanced and diversified consumption pattern, more interest has been in western dessert. As a result, macaroon made of almond powder has rapidly been consumed (Choi, Lim, Jung, Yoo, & Hawng, 2015; Park et al., 2013; Yoo, 2015).

The research on macaroon simply focused on the addition of gaba rice powder and xylose (Choi et al., 2015), *Eclipta alba* (Kim, 2015), black ginseng powder (Peam, 2013), and Korean red peppers and gaba rice (Yoo, 2015). More studies are needed.

Therefore, this study made macaroon with the addition of *Helianthus tuberosus* L. powder so as to increase the application of *Helianthus tuberosus* L. powder to food products and look into the quality characteristics depending on an addition ratio.

MATERIAL AND METHODS

Materials

In the study, *Helianthus tuberosus* L. powder (Agapefood Co., GyeongSan, Korea) was purchased in Feb. 2016 and sieved (100 mesh). Eggs (Pulmuone, Co., Seoul, Korea), sugar (Samyang, Co., Incheon, Korea) and Almond powder (Onefood, Kimpo, Korea) were used. The approximate composition of *Helianthus tuberosus* L. powder is shown in Table 1.

Material Mixing Ratio of Macaroon

This study first conducted a preliminary experiment based on the advanced research of macaroon cookie (Peam, 2013), and then made change and supplementation. After that, as shown in Table 2, *Helianthus tuberosus* L. powder 0%, 0.5%, 1.0%, 1.5%, and 2.0% were added, respectively, to make macaroon.

Table 1. Approximate composition of *Helianthus tuberosus* L. powder (g)

Helianthus tuberosus L. powder				
Carbohydrate	Moisture	Crude protein	Crude lipid	Crude ash
70.13±0.52[1)]	3.73±0.09	9.72±0.78	0.55±0.01	5.57±0.42

[1)] Mean±S.D.

Preparation of Macaroon added with Helianthus tuberosus L. Powder

A kneader (KM-800, Kenwood, England) was used to make foam with 30g of egg white. And then, the ground fined sugar (30 g) was put in the egg white foam, and was mixed together 3 seconds. In the state, 40g of almond powder and each ratio of *Helianthus tuberosus* L. powder were put and mixed together 10 seconds. The mixed dough was put in a pan by 10 mL, and was baked in a preheated oven (HB-428GB, Samsung, Korea) at 160℃ for 15 minutes. After that, the dough was cooled 4 hours before being used for experiment.

Moisture

The moisture content was repeatedly measured by a moisture analyzer (MS-70, A&D Cp., Tokyo, Japan), and the mean was calculated.

Table 2. Formulas for the macaroon cookies added with *Helianthus tuberosus* L. powder (g)

Ingredients	*Helianthus tuberosus* L. powder (%, w/w)				
	Control[1)]	0.5[2)]	1.0[3)]	1.5[4)]	2.0[5)]
Egg white	30	30	30	30	30
Helianthus tuberosus L. powder	0	2	4	6	8
Almond powder	40	28	36	34	32
Sugar	30	30	30	30	30

[1)] Control : Almond powder 100%
[2)] Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
[3)] Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
[4)] Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
[5)] Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%

Color Evaluation

Chromaticity was repeatedly measured by a color meter (JX777, Minolta, Japan), and the mean was presented with Hunter's L value, a value, and b value. At this time the calibration value of standard plate was L=98.46, a=−0.23, b=+1.02, respectively.

Spread Factor

For spread factor, the diameter and height of macaroon were measured, and the spread was repeatedly measured by the modified AACC (10-50D) (AACC, 2000) method. After that, the mean was measured.

$$\text{Spread factor} = \frac{\text{Average width of 6 cookies (mm)}}{\text{Average thickness of 6 cookies (mm)}}$$

Content of Total Phenol Compounds

The content of total phenol compounds was measured in compliance with Folin-Denis's phenol method. In the sample 0.2 mL, 2N Folin-Ciocalteau reagent 0.2 mL was added, and then the sample was left alone 3 minutes. After that, 10% sodium carbonate (Na_2CO_3) 3 mL was added for reaction 1 hour in a dark place. At 765 nm, absorbance was measured. As standard material, gallic acid was used to draw calibration curve, which was presented with mg Gallic acid of cookie 10g. Three experiments were performed repeatedly, and the mean and standard deviation were calculated.

DPPH (1,1-diphenyl-2-picrylhydrazyl) Radical Scavenging Activity

DPPH radical scavenging activity was presented by the relative comparison between control group and *Helianthus tuberosus* L. addition group. In advanced research of macaroon cookie (Lee, Hwang, Liang, & Mau, 2007) method, DPPH radical scavenging activity was measured for comparative analysis. In other words, DPPH solution (1.5×10^{-4}) 1 mL was added in the sample liquid 4 mL, and was stirred together. The mixed one was left alone 30 minutes in a dark place. The absorbance was measured at 517 nm. After DPPH solution was added in ethanol, the absorbance of control group was measured. DPPH radical scavenging activity was presented with percentage. After three repeated experiments, the mean and standard deviation were calculated.

Texture Analysis

Texture of the macaroon to which *Helianthus tuberosus* L. powder was added was repeatedly measured three times by a texture analyzer (TAXT Express v 2.1, London, England) in the conditions of Table 3. And the mean was calculated. At this time, the measured items were hardness, cohesiveness, gumminess, springiness and chewiness.

Sensory Analysis

A assessors of 30 were recruited university students in the major of culinary (Seoul, Korea) from July 11, 2016 to July 16, 2016. For sensory test, 15 men and women in their 20s to 30s who previously had education and recognized the purpose of this study and evaluation method were selected. All samples were put on the white dish and provided to the panelists. They was recommended to rinse their mouth after each evaluation of sample. The evaluated items were color, flavor, taste, texture, overall acceptability and seven point scale was applied. The better an item was evaluated, the closer the points were to 7; the worse evaluated, the closer to 1. Each panelist conducted three trials in a row for evaluation.

Statistical Analysis

SPSS (Statistical Package for Social Sciences, ver. 14.0, SPSS Inc., IL, USA) program was used to calculate mean± standard and conduct ANOVA test. As post-hoc test, Duncan's mul-

Table 3. Operating condition for texture profile analysis

Classification	Condition
Pretest speed	10.0 mm/sec
Test speed	1.0 mm/sec
Posttest speed	1.0 mm/sec
Probe	P10(10 mm DIA cylinder)
Sample area	3.0 mm^2
Contact force	5.0 g
Threshold	20.0 g
Distance	2.0 mm
Strain deformation	90.0%

tiple range test was carried out at a significance level of 5%.

RESULTS AND DISCUSSION

Moisture of Macaroon Cookie

The moisture content of the macaroon with the addition of *Helianthus tuberosus* L. powder is presented in Table 4. As *Helianthus tuberosus* L. powder was added more, the moisture content tended to decrease more significantly (19.00±0.02～17.61±0.22) (p<0.05). The result is similar to that of *Sulgidduk* research (Park, 2010).

Color Evaluation

Chromaticity of the macaroon with the addition of *Helianthus tuberosus* L. powder is shown in Table 5. Regarding lightness, the control group had 79.60±0.61, or the highest. As *Helianthus tuberosus* L. powder was added more, lightness tended to reduce more significantly (p<0.001). According to *Sulgidduk* research (Park, 2010), *Buchimgaru* research (Kim et al., 2014), cookie research (Park et al., 2013), rice sponge cakes research (Kim et al., 2014), sponge cakes research (Suh & Kim, 2014), and *Mook* research (Kim, 2015), the more *Helianthus tuberosus* L. powder was added, the more lightness tended to decrease significantly. Therefore, it was similar to the result of this study.

Table 4. Chemical composition of macaroon added with *Helianthus tuberosus* L. powder

Sample	Moisture (%)
Control[1)]	19.00±0.02[a6)7)]
0.5[2)]	18.53±0.25[b]
1.0[3)]	18.66±0.11[b]
1.5[4)]	18.38±0.15[b]
2.0[5)]	17.61±0.22[c]
F-value	7.81[***8)]

1) Control : Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at p<0.05 as by Duncan's multiple range test.
7) Mean±S.D.
8) * p<0.05, ** p<0.01, *** p<0.001, ** p<.01, *** p<.001.

Table 5. Hunter's color values of macaroon added with *Helianthus tuberosus* L. powder

Sample	Hunter's color value		
	L value	a value	b value
Control[1)]	79.60±0.61[a6)7)]	0.25±0.12[d]	24.02±1.40[a]
0.5[2)]	70.08±0.42[b]	0.93±0.09[c]	21.71±0.05[b]
1.0[3)]	65.98±0.25[c]	1.25±0.12[b]	19.25±0.87[c]
1.5[4)]	65.09±0.87[c]	1.84±0.15[a]	17.65±1.58[c]
2.0[5)]	62.92±0.13[d]	2.01±0.66[a]	15.13±0.17[d]
F-value	56.83[***8)]	14.75[***]	31.96[***]

1) Control: Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at p<0.05 as by Duncan's multiple range test.
7) Mean±S.D.
8) * p<0.05, ** p<0.01, *** p<0.001.

With regard to redness, 2.0% HTP group had 2.01±0.66, or the highest. The more added, the more redness was increased significantly (p<0.001). According to *Sulgidduk* research (Park, 2010), *Buchimgaru* research (Kim et al., 2013), cookie research (Park et al., 2013), rice sponge cakes research (Kim et al., 2014), and *Mook* research (Kim, 2015), with an increase in *Helianthus tuberosu* L. powder addition, redness tended to increase significantly. Therefore, it was similar to the result of this study. However, sponge cakes research (Suh & Kim, 2014) reported that redness tended to reduce as the power was added more.

Regarding yellowness, the control group had 24.02±1.40, or the highest. As *Helianthus tuberosus* L. powder was added more, yellowness tended to reduce significantly (p<0.001). According to sponge cakes research (Suh & Kim, 2014) and *Mook* research (Kim, 2015), the more *Helianthus tuberosus* L. powder was added, the more yellowness tended to increase significantly. Therefore, it was different from the result of this study.

Spread Factor

The spread factor the macaroon with the addition of *He-*

lianthus tuberosus L. powder is presented in Table 6. The control group had 3.27±0.17 (the highest) and 2.0% MTP group had 2.68±0.05 (the lowest). The control began to be significantly different from 1.0% MTP group (p<0.001). The spread ration tended to reduce as *Helianthus tuberosus* L. powder was added more.

Content of Total Phenol Compounds

The content of total phenol compounds of the macaroon to which *Helianthus tuberosus* L. powder was added is presented in Table 7. As *Helianthus tuberosus* L. powder was added more, the content of total phenol compounds significantly increased to 2.73±0.42~15.88±0.42 (mg/10g) (p<0.0001).

Rice sponge cakes research (Kim et al., 2014) also revealed that the more *Helianthus tuberosus* L. powder was added, the more the content of total phenol compounds significantly increased (p<0.05). Therefore, it was similar to the result of this study. *Buchimgaru* research (Kim et al., 2013) reported that because of a significant increase in total polyphenol contents, anti-oxidation function was excellent.

DPPH Radical Scavenging Activity

DPPH radical scavenging activity of the macaroon with the addition of *Helianthus tuberosus* L. powder is presented in Table 8. Regarding DPPH radical scavenging activity, the control group had 33.59±0.64, and 2.0% HTP group 81.43±0.37. Therefore, as *Helianthus tuberosus* L. powder was added more, DPPH radical scavenging activity significantly increased (p<0.001). According to rice sponge cakes research (Kim et al., 2014), *Buchimgaru* research (Kim et al., 2013), and *Mook* research (Kim, 2015), the more the powder was added, the more DPPH radical scavenging activity was increased. It was similar to the result of this study. Therefore, it is considered that phenol of *Helianthus tuberosus* L. powder led to an improvement in DPPH radical scavenging activity.

Table 6. Spread factors of polyphenol of macaroon added with *Helianthus tuberosus* L. powder

Sample	Spread factor
Control[1)]	3.27±0.17[a6)7)]
0.5[2)]	3.25±0.26[a]
1.0[3)]	3.03±0.04[b]
1.5[4)]	2.87±0.01[c]
2.0[5)]	2.68±0.05[d]
F-value	37.12[***8)]

1) Control: Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at p<0.05 as by Duncan's multiple range test.
7) Mean±S.D.
8) * p<0.05, ** p<0.01, *** p<0.001

Table 7. Content of total phenol compounds of macaroon added with *Helianthus tuberosus* L. powder

Sample	Content of total phenol compounds (mg/10g)
Control[1)]	0.88±0.58[a6)7)]
0.5[2)]	2.73±0.42[b]
1.0[3)]	7.45±1.31[c]
1.5[4)]	13.38±1.63[d]
2.0[5)]	15.88±0.42[e]
F-value	102.17[***8)]

1) Control: Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at p<0.05 as by Duncan's multiple range test.
7) Mean±S.D.
8) * p<0.05, ** p<0.01, *** p<0.001.

Texture Analysis

Texture of the macaroon with the addition of *Helianthus tuberosus* L. powder is shown in Table 9. Regarding hardness, the control group had 342.74±54.58 (the lowest) and 2.0% HTP group 813.31±22.17 (the highest). Therefore, there was significant difference between the two groups (p<0.001). It is considered that as the spread ratio of the macaroon with the addition of *Helianthus tuberosus* L. powder reduced, hardness got stronger. According to rice sponge cakes research (Kim et al., 2014), gaba rice powder and xylose research (Choi et al., 2015), and sponge cakes research (Suh & Kim, 2014), the more *Helianthus tuberosus* L. powder was added, the stronger

Table 8. DPPH radical scavenging activity of macaroon added with *Helianthus tuberosus* L. powder

Sample	DPPH (%)
Control[1)]	33.59±0.64[a6)7)]
0.5[2)]	42.41±0.63[b]
1.0[3)]	52.53±0.70[c]
1.5[4)]	73.08±0.81[d]
2.0[5)]	81.43±0.37[e]
F-value	69.35[***8)]

1) Control: Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at $p<0.05$ as by Duncan's multiple range test.
7) Mean±S.D.
8) * $p<0.05$, ** $p<0.01$, *** $p<0.001$

hardness was. It was similar to the result of this study. However, *Mook* research (Kim, 2015) revealed that the more the power was added, the more hardness was decreased. It was different from the result of this study.

With regard to cohesiveness, 2.0% HTP group had 0.41± 0.04 or the highest. The control group began to be significantly different from *Helianthus tuberosus* L. powder 1.5% HTP group ($p<0.05$). However, according to rice sponge cakes research (Kim et al., 2014), sponge cakes research (Suh & Kim, 2014), and *Mook* research (Kim, 2015), as *Helianthus tuberosus* L. power was added more, cohesiveness tended to decrease. It was different from the result of this study.

Regarding gumminess, the control group was significantly different from the groups with the addition of *Helianthus tuberosus* L. powder ($p<0.001$). The more the powder was added, the more gumminess tended to increase. However, *Mook* research (Kim, 2015) reported that gumminess tended to decrease with a rise in power addition.

With regard to springiness, the control group was significantly different from the groups with the addition of *Helianthus tuberosus* L. powder ($p<0.05$). However, there was no significant difference between the groups with the addition of *Helianthus tuberosus* L. powder ($p<0.05$). *Mook* research (Kim, 2015) also revealed the similar result.

With regard to chewiness, the control group had 185.30± 9.90, and 2.0% HTP group 568.31±24.61. Therefore, as *Helianthus tuberosus* L. powder was added more, chewiness was significantly increased ($p<0.001$). Therefore, it was similar to the result of rice sponge cakes research (Kim et al., 2014). However, *Mook* research (Kim, 2015) reported that chewiness tended to decrease with an increase in power addition.

Sensory Analysis

Sensory test on the macaroon with the addition of *Heli-*

Table 9. Texture values of macaroon added with *Helianthus tuberosus* L. powder

Sample	Hardness	Cohesiveness	Gumminess	Springiness	Chewiness
Control[1)]	342.74±54.58[c6)7)]	0.35±0.03[b]	115.37±6.72[d]	0.46±0.03[b]	185.30±9.90[d]
0.5[2)]	571.78±71.34[b]	0.34±0.01[b]	185.80±50.00[c]	0.57±0.03[a]	210.33±1.67[d]
1.0[3)]	605.97±58.45[b]	0.37±0.01[b]	293.08±43.72[b]	0.58±0.01[a]	385.95±82.24[c]
1.5[4)]	744.26±58.04[a]	0.40±0.01[a]	345.48±26.40[b]	0.60±0.00[a]	440.46±34.77[b]
2.0[5)]	813.31±22.17[a]	0.41±0.04[a]	463.71±30.52[a]	0.61±0.08[a]	568.31±24.61[a]
F-value	83.58[***8)]	0.89[*]	57.21[***]	0.69[*]	62.74[***]

1) Control: Almond powder 100%
2) Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
3) Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
4) Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
5) Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
6) Means in the column with different superscripts are significantly different at $p<0.05$ as by Duncan's multiple range test.
7) Mean±S.D.
8) * $p<0.05$, ** $p<0.01$, *** $p<0.001$

anthus tuberosus L. powder is shown in Table 10. Regarding taste, 1.5% HTP group had 5.50 points (the highest), and 2.0% HTP group 3.08 points (the lowest). There was significant difference in accordance with power addition (p<0.001). The control group (4.41 points) was significantly different from 1.5% HTP (5.50 points) group and 2.0% HTP (2.92 points) group control (4.41 points) (p<0.001). Regarding flavor, 1.5% HTP group had 5.42 points (the highest), and was not significantly different from 0.5% HTP group and 1.0% HTP group (p<0.05). With regard to texture and overall acceptability, 1.5 % HTP had the highest points. Texture and overall acceptability were increased with the addition of *Helianthus tuberosus* L. powder, and were reduced again at 2.0% HTP. When it came to macaroon cooking, how much an ingredient was added influenced sensory factors. Therefore, the macaroon excellent at overall acceptability is considered to be found in 1.5% HTP group.

CONCLUSION

With more interest in well-being, functional dessert has drawn a lot of attraction. In the circumstance, this study began to develop functional macaroon. To increase the application of *Helianthus tuberosus* L. powder as a food product, this researcher made macaroon with the addition of *Helianthus tuberosus* L. powder that was effective in controlling blood sugar and blood cholesterol and improving obesity. And it looked into the quality characteristics depending on an addition ratio. Regarding the macaroon with the addition of *Helianthus tuberosus* L. powder, its moisture content was significantly decreased as the power was added more (p<0.001). With regard to chromaticity, as the powder was added more, lightness and yellowness decreased, whereas redness increased. The content of total phenol compounds and DPPH radical scavenging activity of the macaroon with the addition of *Helianthus tuberosus* L. powder were increased as the power was added more. The addition of *Helianthus tuberosus* L. powder led to a decrease in the spread factor of macaroon, and increases in hardness, gumminess, and chewiness. In sensory test, texture and overall acceptability were increased with the addition of *Helianthus tuberosus* L. powder, and were reduced again at 2.0% HTP. And as color, flavor, and texture were improved, 1.5% HTP showed the most desirable result in terms of overall acceptability. Therefore, if *Helianthus tuberosus* L. powder is added for cooking macaroon, it seems to increase anti-oxidation function and develop functional macaroon with excellent sensory factors. It is likely that based on this study, there would be needed the additional studies such as those on the development of various products using the tea in the confectionary and the biological vitality of the macaroon added with

Table 10. Sensory evaluation of macaroon added with *Helianthus tuberosus* L. powder

Sample	Taste	Color	Flavor	Texture	Overall acceptability
Control[1)]	4.33±0.49[c6)7)]	4.41±0.17[b]	4.29±0.88[b]	4.71±0.28[b]	4.67±0.49[b]
0.5[2)]	4.17±0.38[c]	4.50±0.52[b]	4.42±0.66[b]	4.75±0.45[b]	4.75±0.45[b]
1.0[3)]	4.92±0.51[b]	4.75±0.45[b]	4.58±0.66[b]	4.92±0.66[b]	5.00±0.42[b]
1.5[4)]	5.50±0.67[a]	5.50±0.52[a]	5.42±0.57[a]	5.58±0.51[a]	5.51±0.52[a]
2.0[5)]	3.08±1.16[d]	2.92±0.66[c]	2.98±0.45[c]	3.42±1.08[c]	3.25±0.62[c]
F-value	25.16[***]	33.68[***]	26.81[***]	15.35[**]	19.73[***]

[1)] Control: Almond powder 100%
[2)] Almond powder 99.5%, *Helianthus tuberosus* L. powder 0.5%
[3)] Almond powder 99.0%, *Helianthus tuberosus* L. powder 1.0%
[4)] Almond powder 98.5%, *Helianthus tuberosus* L. powder 1.5%
[5)] Almond powder 98.0%, *Helianthus tuberosus* L. powder 2.0%
[6)] Means in the column with different superscripts are significantly different at p<0.05 as by Duncan's multiple range test.
[7)] Mean±S.D.
[8)] [*] p<0.05, [**] p<0.01, [***] p<0.001

the *Helianthus tuberosus* L.

ACKNOWLEDGEMENTS

This study was supported by research funds from Suwon Women's University in 2016.

REFERENCES

AACC. (2000). *Approved methods of the AACC*. 10th ed. American Association of Cereal Chemists, St. Paul, MN, USA

Choi, Y. S., & Lee, M. H. (2009). Physicochemical characteristics and cokie potentialities of Korean wheat cultivars. *Culinary Science & Hospitality Research, 15*(1), 202-208.

Choi, S. Y., Lim, S. Y., Jung, W. S., Yoo, K. M., & Hwang, I. K. (2015). Studies on quality characteristics and biological activities of macaroons supplemented with gaba rice powder and xylose. *J East Asian Soc Dietary Life 25*, 822-829. doi:10.17495/easdl.2015.10.25.5.822

Hwang, J. Y., Lee, H. H., Jang, J. S., & Kim, Y. C. (2015). Skin-whitening efficacy of *Helianthus tuberosus* ethanol extract and its mechanism of action. *J Invest Cosmetol 11*, 175-183. doi:10.15810/jic.2015.11.3.001

Jung, M. S. (2015). *Quality characteristics of rice dumpling shell with Jerusalem artichoke (Helianthus tuberosus L.) powder.* (MS thesis). Sunchon National University, 1-3, Sunchon, Korea.

Kim, G. C., Kim, H. S., Jo, I. H., Kim, J. S., Kim, M. K., & Jang, Y. E. (2013). Qualitative characteristics and antioxidant activities of *Buchimgaru* supplemented with Jerusalem artichoke powder. *J Korean Soc Food Sci Nurt 42*, 1065-1070. doi:10.3746/jkfn.2013.42.4.1065

Kim, H. D., & Jeong, M. S. (2006). The foretasting experience of herbs and the sensory characteristics of cookies with rosemary and mints. *Culinary Science & Hospitality Research, 12*(2), 222-235.

Kim, H. N., Yu, S. Y., Yoon, W. B., Jang, S. M., Jang, Y. J., & Lee, O. H. (2014). Analysis of nutritional components and physicochemical properties of hot-air dried Jerusalem artichoke powder. *Korean J Food Sci Technol, 46*, 73-78. doi:10.9721/kjfst.2014.46.1.73

Kim, J. I. (2015). *Physicochemical properties of macaroon prepared with Eclipta alba*. (MS thesis). Hansung University, 3-22, Seoul, Korea.

Kim, M. H. (2015). *Quality characteristics and biological activities of mook prepared with Jersalem artichoke powder*. (MS thesis). Kyonggi University, 1-5, Seoul, Korea.

Kim, M. K., Lee, E. J., & Kim, K. H. (2014). Effects of *Helianthus tuberosus* powder on the quality characteristics and antioxidant activity of rice sponge cakes. *Korean J Food Culture, 29*, 195-204. doi:10.7318/kjfc/2014.29.2.195

Kim, S. Y., Oh, D. K., Kim, S. S., & Kim, C. J. (1996). New sweeteners used in manufacturing of non-sugar cookies. *Food Sci Ind, 29*(1), 53-61.

Kim, Y. S., Lee, S. J., Hwang, J. W., Kim, E. H., Park, P. J., & Jeon, B. T. (2011) Antioxidant activity and protective effects of extracts from *Helianthus tuberosus* L. leaves on *t*-BHP induced oxidative stress in Chang cells. *J Korean Soc Food Sci Nutr, 40*, 1525-1531. doi:10.3746/jkfn.2014.40.11.1525

Lee, E. J. (2015). *Quality characteristics of Jochung containint various level of Helianthu tuberosus L. powder*. (MS Thesis). Sejong University, 3-18, Seoul, Korea.

Lee, Y. U., Huang, G. W., Liang, Z. C., & Mau, J. L. (2007). Antioxidant properties of three extracts from *Pleurotus citrinopileatus*. *Food Science and Technology, 40*, 823-833. doi:10.1016/j.lwt.2006.04.002

Park, G. S. (2014). Optimization of muffin preparation upon addition of Jerusalem artichoke powder and oligosaccharide by response surface methodology. *Korean J Food Culture, 29*, 101-110. doi:10.7318/kjfc/2014.29.1.101

Park, H. S. (2010). Quality characteristics of *sulgidduk* by the addition of Jerusalem artichoke powder. *Culinary Science & Hospitality Research, 16*(3), 259-267.

Park, H. Y., An, N. Y., & Ryu, H. K. (2013). The quality characteristics and hypoglycemic effect cookies containing *Helianthus tuberosus* powder. *Korean J Community Living Sci, 24*, 233-241. doi:10.7856/kjcls.2013.24.2.233

Peam, J. W. (2013). *Characteristics and manufacture of macaroon cookie prepared with black ginseng powder*. (MS thesis). Hansung University, 9-11, Seoul, Korea.

Shin, J. Y., Byun, M. W., Noh, B. S., & Choi, E. H. (1991). Noodle characteristics of Jerusalem artichoke added wheat

flour and improving effect of texture modifying agents. *Korean J Food Sci Technol, 23*, 538-545.

Suh, K. H., & Kim, K. H. (2014) Quality characteristics of sponge cake added with *Helianthus tuberosus* powder. *J East Asian Soc Dietary Life, 24*(1), 126-135.

Yoo, K. M. (2015). Development of macaroone with Korean red peppers and gaba rice and evaluation of physiological characteristics. *Korean J Food Nutr, 28*, 351-357. doi:10.9799/ksfan.2015.28.3.351

Received: 25 October, 2016
Revised: 20 December, 2016
Accepted: 22 December, 2016