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Quality Characteristics and Antioxidant Activity of Fruit Dressing Using Lentil (*Lens culinaris* Med. cv, Silvina) Legume

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Abstract: Fruit and vinegar dressings are seasoned mixture usually used as stuffing in foods. Quality characteristics and antioxidant potentials of fruit and vinegar dressings prepared by adding lentil were investigated and compared with those of commercial products. The four dressing samples were named as D-1: fruit dressing purchased from a local store in Daegu, Korea; D-2: grapefruit-sugaring dressing prepared in the present study; D-3: vinegar dressing purchased from the local store in Daegu, Korea; D-4: pineapple-vinegar dressing prepared in the present study. The pH and titratable acidity in all samples ranged from 2.9 to 4.6 and from 0.6 to 1.2%, respectively. The crude protein content was 2.29% for D-2 and 4.03% for D-4, while was not detected in commercial dressing samples, D-1 and D-3. The D-4 sample exhibited the higher levels of Ca (215.40 mg/kg), K (1,105.83 mg/kg), Mg (233.63 mg/kg) and Fe (13.78 mg/kg). The content of total amino acid in D-3 and D-4 samples were 8.269 and 3.419 mg/mL, respectively. The highest content of total phenols (191.13 µg GAE/mL) and DPPH radical scavenging activity (93.69%, Inhibition) were observed in D-4. The results of this study indicated that use of lentil could increase the quality and antioxidant potentials of fruit and vinegar dressings.

Keywords: antioxidant activity, fruit dressing, lentil, quality characteristics

Introduction

Consumers are becoming more conscious of the nutritional profile and safety of food ingredients. Over the last few decades consumers' health consciousness has significantly affected the agrofood market (Azzurra and Paola, 2009). The consumption of natural antioxidants has significantly increased due to their antihypertensive, antiviral and anti-inflammatory properties (Benavente-Garcı´a, 1997). Past studies showed that the daily intake of phenolic-rich food could avert chronic, degenerative and cardiovascular disease such as cancer and atherosclerosis (Ejaz et al., 2006).

Fruits and legumes are rich sources of natural antioxidants and have gained high interest among consumers and the scientific community. Epidemiological studies have demonstrated that the using of natural antioxidants is linked with a lower risk of diseases (Temple, 2000). The defensive effects of natural antioxidants are associated with different groups such as phenolics, amino acids, minerals, vitamins, and carotenoids (Halliwell, 1996). The natural antioxidants also play a vital role in the food, cosmetic, and pharmaceutical industries since they can also be utilised as substitutes for synthetic antioxidants providing protection against oxidative stress from free radicals (Moure et al., 2001).

Consumption of legumes is associated with their health benefits against chronic diseases including cardiovascular disease, type 2 diabetes, and cancer (Vaz-Patto et al., 2015). Legumes contain proteins, carbohydrates, dietary fibre, minerals, and vitamins. They also are a rich source of phenolic compounds. Phenolic compounds play an important role in ageing and age-related disorders by scavenging harmful reactive oxygen species and protect the body from

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oxidative damages (Thériault et al., 2006). In addition, phenolic compounds demonstrated anti-atherosclerotic and anti-inflammatory properties. They have potential to overcome the growth of human cancer cells (Del Rio et al., 2013). On the other hand, the presence of polyphenols linked with dietary fibre also notably affect the physiological properties and health (Saura-Calixto, 2011).

Legume seeds are processed before their consumption in order to enhance the nutritional value and decrease the non-nutritional factors (Martín-Cabrejas et al., 2009). Cooking is one of the most common processing techniques used in legume seeds. After heat treatments of legumes, oligosaccharides, minerals, tannins, and phenolic compounds content significantly reduce. In addition, it is also proved that heat treatment notably enhances protein quality and soluble fibre and decreases the insoluble fibre (Wang et al., 2010).

Lentil protein has high nutritional value, with good Leu/Ile and Leu/Lys ratios (Urbano et al., 2007) and high digestibility (Boye et al., 2010). Since lentil (*Lens culinaris* Med.) shows various potential health benefits such as anticarcinogenic, blood pressure-lowering, hypocholesterolemic and glycemic load-lowering effects (Faris et al., 2013) and the use of this legume in fruit dressing has not been reported so far, the objective of the present study was to investigate the quality characteristics and nutritional profile of fruit and vinegar dressings prepared with lentil. Finding of this study will provide valuable information on the potentiality of preparing novel and functional food ingredients (fruit and vinegar dressings) from lentil.

Materials and Methods

Materials

Lentil (*Lens culinaris* Med. cv. Silvina), grapefruit sugaring, fermented vinegar, salt, olive oil, pineapple vinegar, lemon sugaring, soy sauce, sesame (*Sesamum indicum* L.), crude sugar, onion (*Allium cepa* L.) powder, garlic (*Allium sativum* L.) powder, ginger (*Zingiber officinale* Rosc.) powder, sesame oil, pepper oil, and mustard (*Brassica alba* L.) were purchased from local markets in Korea. All the chemicals and reagents were purchased from Sigma (St. Louis, MO, USA) and Aldrich (Milwaukee, USA).

Preparation of lentil paste

One hundred-twenty grams of lentil was put into 1300 mL of water and heated at 100℃ for 20 min. The mixture was blended using a meat chopper and again heated at 100℃ for 20 min. The mixture was added to 150 g of soybean protein isolate and was homogenized (AM-6, Nissei Co, Ltd., Tokyo, Japan). The mixture of lentil paste was allowed to cool at room temperature.

Preparation of fruit and vinegar dressings

The lentil paste and the other ingredients mentioned in Table 1 were mixed thoroughly. The mixture was subjected to heating at 75℃ for 15 min. The fruit and vinegar dressing samples were named as — D-1: fruit dressing purchased from a local store in Daegu, Korea; D-2: grapefruit-sugaring dressing prepared in the present study; D-3: vinegar dressing purchased from the local store in Daegu, Korea; D-4: pineapple-vinegar dressing prepared in the present study.

Table 1. Recipe of fruit and vinegar dressings prepared by adding lentil paste

Ingredient	Grapefruit-sugaring dressing (%)	Pineapple-vinegar dressing (%)
Lentil (*Lens culinaris Med*. cv. Silvina) paste	24.8	22.7
Grapefruit sugaring	49.7	0
Fermented vinegar	12.5	0
Salt	0.6	0
Olive oil	12.4	17.0
Pineapple vinegar	0	22.7
Lemon sugaring	0	5.7
Soy sauce	0	17.0
Sesame (*Sesamum indicum* L.) seed	0	1.1
Crude sugar	0	11.4
Onion (*Allium cepa* L.) powder	0	0.3
Garlic (*Allium sativum* L.) powder	0	0.3
Ginger (*Zingiber officinale* Rosc.) powder	0	0.3

Sesame oil	0	0.6
Pepper oil	0	0.3
Mustard (*Brassica alba* L.)	0	0.6

Chemical characteristics

The pH of dressing samples was measured using a pH Meter (Model 250, Beckman Coulter, Inc., Fullerton, CA, USA). Crude protein (CP) was analyzed following Kjeldahl method (AOAC, 1990). Titratable acidity (acetic acid in g/L) was measured by adding 5 g of dressing sample to 125 mL of deionized water and titrating with 0.1 N sodium hydroxide to an endpoint pH 8.2. Soluble solid content expressed as °Brix was determined using a hand refractometer (RX-5000α, Atago, Tokyo, Japan)

Colour measurement

L (lightness), a (redness, + or greenness, –), b (yellowness, + or blueness, –) values of dressing samples were measured using a Chroma meter (CR-300, Minolta Corp., Japan). The 'L' value is a measure of lightness, from completely opaque (0) to completely transparent (100). The 'a' value is a measure of redness ('–a' greenness), and the 'b' value measures yellowness ('–b' blueness). A Minolta calibration plate (YCIE= 94.5, XCIE= 0.3160, YCIE= 0.330) and a Hunter Lab standard plate (L= 97.51, a= –0.18, b= +1.67) were used to standardize the instrument with D65 illuminant (Kim et al., 2015).

Total phenol content (TPC)

The total phenol contents of the dressing samples were estimated according to the Folin-Ciocalteau method (Singleton, 1999) with some modification. One gram of dressing sample and 1000 µL of 2% (w/v) aqueous Na_2CO_3 were mixed in vortex and kept for 3 min, then 50 µL of 1 N Folin Ciocalteau reagent was added to the mixture and incubated at room temperature in dark for 30 min. The absorbance was measured at 750 nm using a microplate spectrophotometer (Multiskan GO, Thermo Fisher Scientific Oy, Vantaa, Finland). Gallic acid was used as standard to make a calibration curve. Total phenols were determined as gallic acid equivalents (µg GAE/mL dressing).

DPPH radical scavenging activity

The radical scavenging potential of dressing was measured using 1,1-diphenly-2-picrylhydrazyl (DPPH) according to the methods described by Cheung et al. (2003) with some modifications. One hundred microliters of 0.1% DPPH methanol solution was mixed with 0.1 mL of sample. The mixture was left to stand at room temperature in dark for 30 min, and then absorbance was measured at 517 nm (Multiskan GO Microplate Spectrophotometer; Thermo Fisher Scientific). The radical-scavenging activity (RSA) was calculated as a percentage inhibition using the following equation.

$$\% \text{ inhibition} = (1\text{-}S_{ab}/C_{ab}) \times 100$$

where, S_{ab} is the absorbance of the sample and DPPH solution; C_{ab} is absorbance of DPPH solution without sample.

Free amino acids profile

The freeze-dried samples were ground into fine particle and sieved (100 mesh) for chemical analysis. One gram of sample powder was diluted in 10 mL of 3% trichloroacetic acid solution, left at room temperature for 1 h, and centrifuged at 19319 ×g for 15 min. The collected supernatant was filtered through a Millipore 0.22-syringe filter. Amino acids were separated using an automatic amino acid analyzer (Biochrom 20, Pharmacia Bioteeh Co., Sweden). Each filtered sample solution of 10 µl was injected. All determinations were done in duplicate.

Mineral content

Sample (0.5 g) was put into a cup and 15 mL of HNO_3 (65%) was added. The mixture was diluted to 50 mL with distilled water. Mineral concentrations were determined using inductively coupled plasma atomic emission spectrometer (ICP AES: Varian Vista, Varian Australia, Victoria, Australia) following Skujins (1998). The instrument was calibrated using known standards for each mineral. Average value of 2 replicate samples was reported.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) and differences between means at $p<0.05$ were analyzed using the Tukey test. SAS 9.3 (SAS Institute Inc.) was used for statistical analysis. All chemical measurements were replicated three times unless mentioned otherwise and the average values were reported.

Results and Discussion

General composition

A general composition such as crude protein, pH, titratable acidity and soluble solid are shown in Table 2. Sample D-4 (4.03%) demonstrated the highest CP contents followed by D-2 (2.29%) while CP was not detected in D-1 and D-3. The range of the pH was from 2.91 to 4.61 and D-4 showed the highest value. With the dressing of pineapple-vinegar, the pH value higher than the other fruit dressing. A change of just

0.3 in the pH value indicates a doubling of acid concentration. Higher pH value for D-4 (4.61) than D-2 (3.51) might be due to large proportion of vinegar in the vinegar dressing (Table 1). Variations of pH can be influenced on flavour, shelf-life and consistency (Aysegul et al., 2007). The Brix was significantly ($p<0.05$) highest (40.2) in D-4. The samples showed Brix in the sequence of D-4 > D-2 >D-3 > D-1. Overall, D-4 that was prepared with pineapple vinegar lentil paste demonstrated as a good source of crude protein and Brix. The crude protein content in the D-2 and D-4 might be from the lentil paste (Urbano et al., 2007; Boye et al., 2010).

Table 2. General composition of fruit and vinegar dressings

	Sample[1)]			
	D-1	D-2	D-3	D-4
Crude protein (%)	ND	2.29±0.06[3)]	ND[4)]	4.03±0.05
pH	2.91±0.01d	3.51±0.01b	3.21±0.01c	4.61±0.01a
Titratable acidity[2)] (%)	0.81±0.02c	0.61±0.02d	1.21±0.02a	0.91±0.02b
Soluble solid (°Brix)	6.0±0.2d	43.8±0.2a	16.0±0.2c	40.2±0.2b

[1)] D-1: fruit dressing purchased from a local store in Daegu, Korea; D-2: grapefruit-sugaring dressing prepared in the present study; D-3: vinegar dressing purchased from the local store in Daegu, Korea; D-4: pineapple-vinegar dressing prepared in the present study.
[2)]As acetic aicd.
[3)]Values are mean±standard deviation of triplicate experiments. The values followed by the different letters in the same row are significantly different, according to Tukey test ($p<0.05$).
[4)]ND: non detected.

Hunter's colour value

The colour value of the food plays a vital role in the acceptability of the consumers. Hunter's colour values of fruit and vinegar dressing samples are shown in Table 3. D-2 possessed the highest (56.54) value for lightness and D-3 showed the lowest (45.98) lightness value while D-3 had greater value for redness than D-2. The colour value enhanced from redness to yellowness in D-1, D-2, and D4. The colour of the samples was changed according to the presence of different kinds of fruit dressings.

Table 3. Hunter`s colour value of fruit and vinegar dressings

Sample[1)]	Colour value[2)]		
	L (Lightness)	a (Redness)	b (Yellowness)
D-1	55.12±1.43a[3)]	-1.59±0.08d	12.61±0.56a
D-2	56.54±2.23a	1.20±0.03c	7.74±0.69b
D-3	45.98±1.12c	3.30±0.30a	2.55±0.22c
D-4	49.32±1.59b	1.87±0.10b	2.39±0.22c

[1)]Samples are defined in Table 2.
[2)]L: lightness (100, white; 0, black), a: redness (-, green; +, red), b: yellowness (-, blue; +, yellow).
[3)]Values are mean±standard deviation of triplicate experiments. The values followed by the different letters in the same column are significantly different, according to Tukey test ($p<0.05$).

Colour is an important sensory evaluation of food and contributes significant position in overall food quality and characteristics. It effects on flavour, sweetness and saltiness as well as it acts as an important estimator of moisture content, over-processing, and pigment content (Fergum, 1991).

Mineral content

Essential and non-essential minerals were detected in the four samples (Table 4). Potassium (K), magnesium (Mg), and calcium (Ca) were at higher concentration in D-4 while D-3 possessed the highest (10915.99 mg/kg) value for sodium (Na). Iron (Fe) was detected only in D-4. Zinc (Zn), manganese (Mn) and other heavy metals such as arsenic (As), cadmium (Cd), mercury (Hg) and lead (Pb) were not detected in the samples.

Table 4. Mineral content (mg/kg) of fruit and vinegar dressings

Element	Sample[1)]			
	D-1	D-2	D-3	D-4
K	479.12±5.1d[2)]	563.26±4.1c	810.86±5.2b	1105.83±4.3a
Mg	52.80±3.6d	182.61±2.7b	110.76±3.5c	233.62±3.2a
Ca	132.90±2.2c	107.19±2.1d	141.54±2.5b	275.40±2.6a
Na	3070.41±8.1c	2865.37±7.1d	10915.99±7.5a	9353.63±9.0b
Fe	ND[3)]	ND	ND	13.78±1.12
Zn	ND	ND	ND	ND
Mn	ND	ND	ND	ND
As	ND	ND	ND	ND
Cd	ND	ND	ND	ND
Hg	ND	ND	ND	ND
Pb	ND	ND	ND	ND

[1)]Samples are defined in Table 2.
[2)]Quoted values are mean±standard deviation of duplicate experiments. The values followed by the different letters in the same row are significantly different, according to Tukey test ($p<0.05$).
[3)]ND: non detected.

These minerals play a vital role in the proper human body functioning. Mg needs for making protein, muscle contraction and immune system (Saris et al., 2000). Ca plays a role for healthy bones and teeth and assists in relaxation and contraction of muscles. It is also important for blood clotting and blood pressure regulation (Brini, 2013). K is required for nerve transmission and muscle contraction. Na is famous for fluid balance, muscle contraction and nerve transmission (Pohl et al., 2013). All the four dressing samples (D-1, D-2, D-3 and D-4) were rich in minerals K, Mg, Ca and Na.

Free amino acid

Thirty-seven free amino acids were analyzed in the samples **(**Table 5). Human body cannot produce essential amino acids. Theses essential amino acids are required to be supplied through foods. Statistical differences ($p<0.05$) in the free amino acids of samples were observed. Overall, D-3 showed a notable value of amino acids and had the highest contents among all the other 4 samples. This difference might be due to the presence of different fruit dressing. D-3 possessed 0.647, 0.261, 0.357 and 1.078 mg/mL aspartic acid, threonine, serine and glutamic acid, respectively.

Table 5. Free amino acid (mg/mL) of fruit and vinegar dressings

Amino acid	Sample[1)]			
	D-1	D-2	D-3	D-4
Phosphoserine	ND[2)]	ND	ND	ND
Taurine	ND	ND	0.005[3)]	0.009
Phospho ethanol amine	0.507	ND	1.775	1.321
Urea	ND	ND	ND	ND
Aspartic acid	0.059	0.068	0.647	0.284
Threonine	0.007	0.003	0.261	0.090
Serine	0.037	0.019	0.357	0.127
Glutamic acid	0.008	0.020	1.078	0.353
Sarcosine	ND	ND	ND	ND
α-Amino adipic acid	ND	ND	ND	ND
Glycine	0.009	0.005	0.214	0.075
Alanine	0.028	0.021	0.421	0.137

Citrulline	ND	ND	0.055	0.009
α-Amino-n-butyric acid	0.001	0.001	ND	ND
Valine	0.015	0.006	0.404	0.139
Cystine	ND	ND	ND	ND
Methionine	0.018	0.002	0.102	0.027
Cystathionine	ND	ND	ND	ND
Isoleucine	0.008	0.001	0.358	0.126
Leucine	0.008	0.002	0.550	0.185
Tyrosine	0.011	0.002	0.082	0.024
Phenylalanine	0.009	0.005	0.307	0.110
β-Alanine	0.008	0.008	0.058	0.040
β-Amino isobutyric acid	ND	ND	0.055	0.026
γ-Amino-n-butyric acid	0.019	0.040	0.087	0.019
Ethanol amine	0.005	ND	0.012	ND
Hydroxylysine	ND	ND	ND	ND
Ornithine	ND	ND	ND	ND
Lysine	0.007	0.004	0.383	0.111
1-Methylhistidine	ND	0.001	ND	ND
Histidine	0.005	0.002	0.089	0.028
3-Methylhistidine	ND	ND	ND	ND
Anserine	ND	ND	ND	ND
Carnosine	ND	ND	ND	ND
Arginine	0.006	0.094	0.589	0.049
Hydroxy proline	0.003	ND	ND	ND
Proline	0.001	0.064	0.380	0.130

[1)]Samples are defined in Table 2.
[2)]ND: non detected.
[3)]Quoted values are average of duplicate experiments.

Alanine and glutamic acid play a vital role in human health. Alanine has a significant role in maintaining a balanced amount of glucose in the human body via glucose-alanine cycle (Layman et al., 2006). Valine is essential for muscle development and coordination. It also plays its role in a central nervous system. Threonine is needed for the production of glycine and serine that helps in the synthesis of collagen and muscle coordination. It also boosts the immune system and acts as an immuno-stimulant (Maimaiti et al., 2007). Leucine facilitates in regulating oxidative glucose utilization and contributes to the healing of bone and skin damages. Aspartic acid helps as a precursor for the preparation of several essential amino acids and aids as a neurotransmitter in the brain (Kirma et al., 2012). Glutamic acid is well known for boosting the taste of food and help in brain metabolism and use as the treatment of nervous disorders (Chen et al., 2005).

Antioxidant activity

Total phenolic content

Foods, vegetables and medicinal plants contain phenolic compounds which possess the antioxidant potentials (Maksimovic et al., 2005). Considerable variation was observed in total phenolic contents among the four dressing samples (Table 6). The findings showed that the dressing samples are good source of antioxidants as the phenolic compounds minimise lipid peroxidation (Wojdylo et al., 2007). The total phenolic contents of the four sample were in the range of 191.13 to 65.56 µg GAE/mL. D-4 exhibited significantly ($p<0.05$) the highest (191.13) value of total phenolic contents among all other samples. The higher value of total phenolic contents presence is considered beneficial for human health. The difference among different samples might be due to different types of fruit dressing and the characteristics of fruit. Meanwhile, D-4 can be considered as a good source of phenolic contents.

DPPH radical-scavenging activity

DPPH radical-scavenging activity was used to determine the antioxidant activity in the fruit and vinegar dressing samples (Table 6). The DPPH assay is one of the most efficient methods for evaluating the antioxidant ability of food samples. The free radicals in DPPH are reduced in the presence of antioxidants and give rise to a colourless solution (Shon et al., 2003). The DPPH radical-scavenging activity was expressed at a high value (93.69%) for D-4 as compare to the other samples in which D-1 showed the lowest value (19.44%). The antioxidant activity of four fruit dressing samples on the base of the DPPH radical was in the order D-4 > D-3 > D-2 > D-1. Our findings concluded that D-4 had strong DPPH radical-scavenging ability.

Table 6. DPPH radical scavenging activities and total phenol content of fruit and vinegar dressings

Sample[1)]	Total phenol content (μg GAE[2)]/ml of sample)	DPPH[3)] (%, Inhibition)
D-1	65.56±1.48d[4)]	19.55±0.18d
D-2	83.31±0.82c	51.93±0.08c
D-3	128.05±1.44b	79.67±0.03b
D-4	191.13±5.76a	93.69±0.05a

[1)]Samples are defined in Table 2.
[2)]GAE: gallic acid equivalent.
[3)]DPPH: DPPH free radical scavenging activity.
[4)]Quoted values are mean±standard deviation of duplicate experiments. The values followed by the different letters in the same column are significantly different, according to Tukey test ($p<0.05$).

Conclusions

The fruit and vinegar dressings prepared by adding lentil were investigated for their physicochemical properties and antioxidant potentials. The samples were compared with the commercially available samples in the markets. Protein content was not found in the commercial samples but 2.29-4.03% of proteins were found in the samples prepared in the present study. Minerals like K and Mg in the fruit and vinegar dressing samples were higher as compared to the commercial products of the same category. Similarly, the antioxidant potential and total phenolic contents were also significantly low in the commercial fruit and vinegar dressings. The results of this study indicated that lentil could be used in the fruit and vinegar dressings to enhance their quality and antioxidant potentials.

Conflict of Interest

The authors declare no conflict of interest.

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