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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

CHEMICAL COMPOSITION AND ANTIOXIDANT ACTIVITY OF DIFFERENT SOYBEAN CULTIVARS FROM MEKONG RIVER DELTA - VIETNAM

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ABSTRACT

In recent years, the studying of nutrition component and antioxidant charateristics from natural food sources has become more necessary and popular. In the present work, seeds of 7 cultivars from Mekong River Delta, Vietnam (MTĐ 760, MTĐ 176, MTĐ 878.2, MTĐ 517.8, Cao San, Japanese cultivar 17A and Nam Vang) of soybean (*Glycine max L. Merr.*) were investigated for proximate composition and antioxidant potential. Soybean seeds were found to be a rich source of protein (37.56 – 40.32%, db), the lipid contents were found to be 18.16 – 20.93% db, carbohydrate were from 30.06 to 33.19% db, its reducing sugar seizes from 2.47 – 3.42%, db. Beside, the variation of fiber and ash were in range of 4.10 – 5.20% and 4.73 – 5.35% db, respectively. Acetone extracts of the soybean seeds cultivars exhibited a good antioxidant activity as determined in terms of total phenolic contents – TPC (2.49 ± 0.04 – 3.10 ± 0.03 mg GAE/g), total flavonoid content – TFC (1.58 ± 0.05 – 2.38 ± 0.05 mg QE/g), Vitamin C (6.24 ± 0.12 – 7.12 ± 0.12 mg/g) and IC50 values (9.14 ± 0.04 - 10.65 ± 0.06 mg/ml). The MTĐ 760 cultivar was accessed as the best raw material for functional and high protein soy food processing such as soymilk and tofu due to the highest levels of protein, TPC as well as antioxidant capacity.

KEYWORDS: Chemical composition, total phenolic content, total flavonoids content, antioxidant capacity, soybean seeds.

INTRODUCTION

Soybean (*Glycine max L. Merr.*) is one of the most important crops for human and animal consumption [1]. Soybean seeds contain very high levels of protein (about 40%), oil (about 20%), carbohydrate conjugates, amino acids, and inorganic materials (minerals). In addition, an impressive array of antioxidants that make the antioxidant capacity for soybean seeds such as polyphenols, flavonoids and vitamins. Soy antioxidant activities and the role of soy antioxidants have been recognized that they can contribute to health promotion in the prevention of cancers including breast and prostate cancers, cardiovascular diseases, bone health, and diabetes [2-4]. Thus, they are interested in both the nutritional value and the potential health benefits.

Soy processing industries select raw material based on weight, moisture, impurities and grain damage. Differences in chemical and physical properties of soybean cultivars are not taken into consideration in soy food processing. Information on these characteristics could help food industries obtain products with better functional and nutritional qualities with greater cost benefits [5].

According to their different uses, soybean cultivars are classified as grain‑type, which are conventional soybeans for oil and animal feeding, and food-type, which are those for human consumption foods (tempeh, tofu, soy flour and soy milk) [6]. Therefore, soybean cultivars for human consumption should present special chemical and functional characteristics. Therefore, soybean cultivars for human consumption should present special chemical, physical and sensory characteristics. Soybean cultivars with high protein content allow the production of foods with superior nutritional value and yield, such as soy milk and tofu [6]. The soybean cultivars with high content of antioxidant can increase functional properties of soy foods [7].

Many varieties of soybean were grown in Mekong River Delta, Vietnam. However, they are no data published for the chemical compositions and antioxidant components of these varieties. The information about the chemical and antioxidant characteristics of food-type soybean cultivars could help soy food industries to properly process high-quality products for human consumption [5]. The objective of this work was to evaluate chemical and antioxidant characteristics of grains of soybean cultivars from Mekong River Delta, Vietnam.

MATERIALS AND METHODS

Preparation of samples

The soybean (*Glycine max L.*) cultivars evaluated were: MTĐ 760, MTĐ 176, MTĐ 878.2 and MTĐ 517.8 were supplied from Department of Agricultural Genetic, College of Agricultural and Applied Biology, Cantho University, Vietnam; Cao San and Japanese cultivar 17A were supplied from Seed production Center of Dong Thap and Nam Vang cultivar was collected from Seed production Center of An Giang, Vietnam.

The cleaned soybean seeds were ground and stored at 5ºC for chemical compositions analysis. Ground soybeans were defatted in a Soxhlet extractor for 10h with petroleum ether [8] and then were stored at 5ºC after removal of petroleum ether for TPC, TFC and antioxidant capacity determination. For each treatment, a mass of 0.5g of defatted soybean powder was extracted using aqueous acetone 69% as solvent for three cycles. The ratio of defatted soybean powder and solvent was 1:8 (w/v), the extraction process was carried out at 42ºC during 184min for each cycle [9]. The triplicate extracts were combined for determination the TPC, TFC and antioxidant potential [10].

Determination of the chemical compositions

- Total protein, total lipid, ash, fiber, reducing sugar, moisture and carbohydrate content were determined following the Vietnamese standard (TCVN 4295 – 86) [11]. All chemical components were displayed as percent on dry basic.

- Ascorbic acid (vitamin C) content was determined using the 2,6-dichloroindo-phenol method [12].

Determination of the TPC

Determination of the TPC in the extracts: The TPC was estimated by Folin-Ciocalteu method [13]. The total phenolic content of samples was expressed as milligrams garlic acid equivalents per gram of dry matter (mg GAE/g).

Determination of the TFC

The TFC was determined by the Dowd method with slight modification [14] and using a standard curve of quercetin. Thus, the results were expressed as milligrams of quercetin equivalents (QE) per g of dry matter sample (mg QE/g).

Antioxidant capacity

Antioxidant activity of the phytochemicals extracted from soybean was assessed by measuring their radical scavenging activity that was measured by the bleaching of the purple-coloured methanol solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH). This spectrophotometric assay uses stable DPPH radical as a reagent. The DPPH radical scavenging activity was evaluated from the difference in peak area decrease of the DPPH radical detected at 517nm between a blank and a sample [15]. Percentage of radical scavenging activity was plotted against the corresponding concentration of the extract (µg/ml) to obtain IC50 value in mg/ml. IC50 is defined as the amount of antioxidant material required to scavenge 50% of free radical in the assay system. The IC50values are inversely proportional to the antioxidant activity.

Statistical analysis

All evaluations of total phenolic content, total flavonoid content, antioxidant activity were performed thrice. The data were submitted to analysis of variance (ANOVA) and were expressed as mean values ± standard deviation and were analysed using Principal Component Analysis (PCA) with full cross-validation. PCA was assessed using XLSTAT software version 2015.

RESULTS AND DISCUSSION

Chemical composition of soybean seeds

The chemical composition results of the seven studied soybean cultivars are showed in Table 1. There are significant differences in chemical compositions from different soybean cultivars. Protein was the major compound, ranging from 37.56 ± 0.15% in MTĐ 517.8 to 40.32 ± 0.22% in MTĐ 760, protein content in MTĐ 760 cultivar is significant higher than that in the others and suitable for processing of rich protein soybean products such as soymilk or tofu. Carbohydrate presented the second predominant values, between 30.06 ± 0.27% in Nam Vang to 33.19 ± 0.14% in MTĐ 176, within it reducing sugar seizes from 2.47± 0.26 – 3.42 ± 0.15%. Lipid also occupies a significant proportion in the composition of the soybean seeds, between 18.16 ± 0.12% in MTĐ 760 and 20.93 ±

0.12% in MTĐ 878.2. Beside, soybeans contain amounts of fiber (4.10 ± 0.12 – 5.20 ± 0.17%) and ash (4.73 ± 0.06 – 5.35 ± 0.09%).

Those values confirm that soybean are an excellent source of protein, carbohydrate and lipid that can supply required nutrition and energy for people diets. These results were compared with the ones previously obtained from the study of Silva et al. (2009) on the chemical compositions of some Brazil soybean cultivars [5], where protein contents range from 40.12 to 42.70% (db), lipid contents are in range of 18.89 – 19.98% (db) and carbohydrate occupies from 30.64 to 34.38% (db). There are some differences about protein and lipid contents can be noticed, probably due to the different varieties as well as the location of the orchard from where the samples were collected. So, these results are the evidence that varieties can influence the chemical composition of soybean seeds.

Table 1. Chemical compositions of different soybean varieties

Samples	Protein (%)	Lipid (%)	Carbohydrate (%)	Ash (%)	Fiber (%)	Reducing sugar (%)
MTĐ 760	$40.32^{a} \pm 0.22$	$18.16^{f} \pm 0.12$	$30.97^{d} \pm 0.33$	$5.35^{a} \pm 0.09$	$5.20^{a} \pm 0.17$	$2.47^{d} \pm 0.26$
Japanese 17A	$39.21^{b} \pm 0.04$	$19.77^{c} \pm 0.14$	$31.87^{bc} \pm 0.23$	$5.01^{b} \pm 0.19$	$4.14^{d} \pm 0.12$	$3.22^{abc} \pm 0.05$
Nam Vang	$38.69^{c} \pm 0.24$	$20.82^{a} \pm 0.21$	$30.06^{e} \pm 0.27$	$5.24^{a} \pm 0.06$	$5.18^{a} \pm 0.04$	$2.62^{d} \pm 0.02$
Cao San	$38.47^{c} \pm 0.15$	$18.90^{e} \pm 0.13$	$33.15^{a} \pm 0.38$	$4.83^{cd} \pm 0.06$	$4.66^{c} \pm 0.28$	$3.42^{a} \pm 0.15$
MTĐ 176	$38.11^{d} \pm 0.08$	$19.32^{d} \pm 0.03$	$33.19^{a} \pm 0.14$	$5.28^{a} \pm 0.11$	$4.10^{d} \pm 0.11$	$3.29^{ab} \pm 0.06$
MTĐ 878.2	$37.76^{e} \pm 0.04$	$20.93^{a} \pm 0.12$	$31.49^{c} \pm 0.17$	$4.98^{bc} \pm 0.06$	$4.84^{bc} \pm 0.13$	$3.01^{c} \pm 0.07$
MTĐ 517.8	$37.56^{e} \pm 0.15$	$20.41^{b} \pm 0.25$	$32.30^{b} \pm 0.07$	$4.73^{d} \pm 0.06$	$5.01^{ab} \pm 0.01$	$3.10^{bc} \pm 0.23$

(Data are presented as mean from triplicate ± SD in dry basic, the same letters within row indicate not significant difference at 5% level)

Antioxidant characteristics of soybean seeds

With regards to total phenolics contents, the soybean seed exhibited a good source of antioxidants, namely TPC (2.49 ± 0.04 – 3.10 ± 0.03 mg GAE/g), TFC (1.58 ± 0.05 – 2.38 ± 0.05 mg QE/g), Vitamin C (6.24 ± 0.12 – 7.12 ± 0.12 mg/g) and IC50 values (9.14 ± 0.04 - 10.65 ± 0.06 mg/ml). Cultivar MTĐ 176 and MTĐ 760 showed the highest levels of these compounds (3.10 ± 0.03 and 3.07 ± 0.04 mg GAE/g) which are significant higher than that of the others (Table 2). It is worth mentioning that these genotypes also showed the lowest IC50 values (9.21 ± 0.06 and 9.18 ± 0.04 mg/ml, respectively), other words, these cultivars display highest antioxidant activities.

The above TPC values were higher than that from the results of Mujić et al. (2011) on soybean cultivars from Croatia (0.87 – 2.16 mg GAE/g) [16]. The findings of Chai *et al*. (2013) concerning phenolic contents and antioxidant activity in germinated and non germinated soybean from Malysia [17] resulted in the very high content of TPC of soybean (8.88 mg GAE/g). This resulted from the difference in varieties and extraction method for analysis.

Table 2. Antioxidant charateristics of different soybean varieties

Samples	TPC (mg GAE/g)	TFC (mg QE/g)	Vitamin C (mg/g)	IC50 (mg/ml)
MTĐ 760	$3.07^{a} \pm 0.04$	$2.16^{b} \pm 0.08$	$6.64^{bc} \pm 0.14$	$9.18^{e} \pm 0.04$
Japanese 17A	$2.88^{c} \pm 0.05$	$2.38^{a} \pm 0.05$	$7.12^{a} \pm 0.12$	$10.14^{c} \pm 0.01$
Nam Vang	$2.71^{d} \pm 0.03$	$1.58^{e} \pm 0.05$	$6.44^{d} \pm 0.03$	$9.14^{e} \pm 0.04$
Cao San	$2.49^{e} \pm 0.04$	$2.15^{b} \pm 0.04$	$6.52^{cd} \pm 0.12$	$9.53^{d} \pm 0.05$
MTĐ 176	$3.10^{a} \pm 0.03$	$1.84^{c} \pm 0.06$	$6.41^{de} \pm 0.11$	$9.21^{e} \pm 0.06$
MTĐ 878.2	$2.83^{d} \pm 0.05$	$2.19^{b} \pm 0.07$	$6.70^{b} \pm 0.01$	$10.65^{a} \pm 0.06$
MTĐ 517.8	$2.96^{b} \pm 0.05$	$1.74^{d} \pm 0.03$	$6.24^{e} \pm 0.12$	$10.51^{b} \pm 0.02$

(Data are presented as mean from triplicate ± SD in dry basic, the same letters within row indicate not significant difference at 5% level)

In this study, no correlation between phenolic contents and antioxidant activity of all examined soybean varieties was observed, for instance, Nam Vang cultivar exhibited a highest antioxidant activity (lowest IC50 value) but its TPC, TFC and vitamin C were not high. Chai *et al*. (2013) also concluded no correlation (p>0.05) observed between antioxidant activities and total phenolic content in soybean extracts. This may be due to the differences in the constituents of polyphenol compounds from different soybean varieties.

Considerable variability in the contents of all other antioxidants was observed. As shown in Table 2, the total flavonoids contents varied over a range between 1.58 ± 0.05 and 2.38 ± 0.05 mg QE/g. The highest level of TFC was recorded in Japanese cultivar 17A, followed by MTĐ 760 and Cao San cultivars. These cultivars displayed relatively low of IC50 values because flavonoids can directly scavenge molecules of active oxygen, including hydrogen peroxide, hydroxyl, and peroxyl radicals [18].

Japanese cultivar 17A also displayed the highest content of vitamin C where this content of all studied soybean cultivars were in range of 6.24 – 7.12mg/g. Japanese cultivar 17A presented the highest in both TFC and vitamin C but it did not had the highest level of total phenolics and lowest level of IC50. It seems that the antioxidant activity of the extract of different soybean cultivars is depended on levels of TPC more than other antioxidants such as TFC and vitamin C.

PCA for chemical composition and antioxidant characteristic of soybean seeds

The results of PCA for chemical compositions of studied soybean cultivars and for chemical compositions combined with antioxidant characteristics of these cultivars were displayed in Figure 1. The MTĐ 760 cultivar was near to TPC, protein, ash items and farthest to IC50 and lipid items (Figure 1A, B) meaning this cultivar had high level of protein, TPC, ash and antioxidant capacity but was low in lipid content. So, it can be used for processing of functional high protein product as soymilk and tofu, specially for low fat products. The MTĐ 176 cultivar was near to TPC and far to IC50 (Figure 1A) but it also was far to protein item (from PC1 axis, Figure 1B), for this reason, it can be used for processing functional food. Because the MTĐ 878.2 and MTĐ 517.8 cultivars were nearest to IC50 and lipid items (Figure 1B), they can not be used for processing functional food but were suitable for oil processing. There was no special characteristic in composition and antioxidant capacity from other soybean cultivars, they can be used for processing normal products.

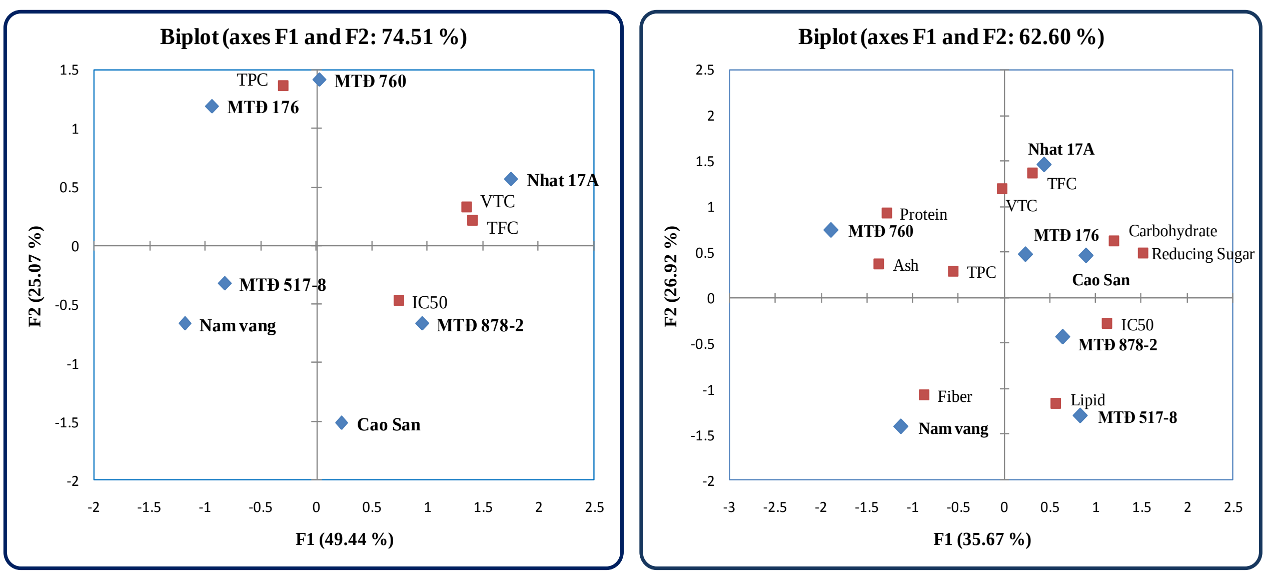

Figure 1. PCA plots for chemical compositions and antioxidant characteristics of studied soybean cultivars

A: PCA plot for chemical compositions of studied soybean cultivars;

B: PCA plot chemical compositions combined with antioxidant characteristics of studied soybean cultivars

CONCLUSION

Significant differences in the chemical composition, TPC, TFC and antioxidant capacity were observed within the soybean cultivars from Mekong River Delta, Vietnam. The main compositions such as protein content ranged from 37.56 ± 0.15 to 40.32 ± 0.22%, lipid contents were in range of 18.16 ± 0.12 and 20.93 ± 0.12% and carbohydrate were from 30.06 ± 0.27 to 33.19 ± 0.14%. The TPC varied from 2.49 ± 0.04 to 3.10 ± 0.03 mg GAE/g and IC50 values were in range of 9.14 ± 0.04 – 10.65 ± 0.06 mg/ml.

The soybean cultivar MTĐ 760 is the best raw material for functional and high protein soy food processing, and it is indicated for tofu, soy milk. MTĐ 176 cultivar can be used for processing functional food, MTĐ 878.2 and MTĐ 517.8 cultivars are suitable for oil processing, while other soybean cultivars can be used for processing normal products.

REFERENCES

1. D. Malenčić, M. Popović and J. Miladinović "Phenolic content and antioxidant properties of soybean (Glycine max (L.) Merr.) seeds." Molecules 12(3): 576-581, 2007.
2. T. B. Clarkson "Soy, soy phytoestrogens and cardiovascular disease."The Journal of Nutrition 132(3): 566S-569S, 2002.
3. V. Jayagopal, P. Albertazzi, E. S. Kilpatrick, E. M. Howarth, P. E. Jennings, *et al.* "Beneficial effects of soy phytoestrogen intake in postmenopausal women with type 2 diabetes." Diabetes care 25(10): 1709-1714, 2002.
4. L. Yan and E. L. Spitznagel "Soy consumption and prostate cancer risk in men: a revisit of a meta-analysis."The American journal of clinical nutrition 89(4): 1155-1163, 2009.
5. J. B. d. Silva, M. C. Carrão-Panizzi and S. H. Prudêncio "Chemical and physical composition of grain-type and food-type soybean for food processing." Pesquisa Agropecuária Brasileira 44(7): 777-784, 2009.
6. K. Liu "Soybeans: chemistry, technology, and utilization". Springer, Month, 1997.
7. E. Aldin, H. A. Reitmeier and P. Murphy "Bitterness of soy extracts containing isoflavones and saponins." Journal of food science 71(3): S211-S215, 2006.
8. S. Weidner, A. Powałka, M. Karamać and R. Amarowicz "Extracts of phenolic compounds from seeds of three wild grapevines—Comparison of their antioxidant activities and the content of phenolic compounds." International journal of molecular sciences 13(3): 3444-3457, 2012.
9. D. T. P. Lien, P. T. B. Tram and H. T. Toan "Response surface methodology optimization for extraction of flavonoids and antioxidant capacity from soybean seeds." 131-135, 2015.
10. T. P. L. Duong, T. B. T. Phan and T. T. Ha "Effects of extraction process on phenolic content and antioxidant activity of soybean." Journal of Food and Nutrition Sciences 3(Special Issue: Food Processing and Food Qualit): 33-38, 2015.
11. "Proceedings of Vietnam argicultural standards." 4(III), 2001.
12. L. Plaza, B. de Ancos and P. M. Cano "Nutritional and health-related compounds in sprouts and seeds of soybean (*Glycine max*), wheat (*Triticum aestivum. L*) and alfalfa (*Medicago sativa*) treated by a new drying method." European food research and technology 216(2): 138-144, 2003.
13. S. Jiang, W. Cai and B. Xu "Food quality improvement of soy milk made from short-time germinated soybeans." Foods 2(2): 198-212, 2013.
14. A. Meda, C. E. Lamien, M. Romito, J. Millogo and O. G. Nacoulma "Determination of the total phenolic, flavonoid and proline contents in Burkina Fasan honey, as well as their radical scavenging activity." Food Chemistry 91(3): 571-577, 2005.
15. J. Liu, C. Wang, Z. Wang, C. Zhang, S. Lu, *et al.* "The antioxidant and free-radical scavenging activities of extract and fractions from corn silk (*Zea mays L*.) and related flavone glycosides." Food Chemistry 126(1): 261-269, 2011.
16. I. Mujić, E. Šertović, S. Jokić, Z. Sarić, V. Alibabić, *et al.* "Isoflavone content and antioxidant properties of soybean seeds." Croatian Journal of Food Science and Technology 3(1): 16-20, 2011.
17. M. Chai, A. Azlan, S. H. Al-Sheraji, F. A. Hassan and K. N. Prasad "Antioxidant Activities and Total Phenolic Content in Germinated and Non-Germinated Legume Extracts Following Alkaline-Acid Hydrolysis." Pakistan journal of Nutrition 12(12): 1036-1041, 2013.
18. K. Gould, J. McKelvie and K. Markham "Do anthocyanins function as antioxidants in leaves? Imaging of H2O2 in red and green leaves after mechanical injury." Plant, Cell & Environment 25(10): 1261-1269, 2002.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

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