World Academy of Science, Engineering and Technology
International Journal of Nutrition and Food Engineering
Vol:6, No:4, 2012

Effect of Pretreatment Method on the Content of Phenolic Compounds, Vitamin C and Antioxidant Activity of Dried Dill

Ruta Galoburda, Zanda Kruma, Karina Ruse

***Abstract*—**Dill contains range of phytochemicals, such as vitamin C and polyphenols, which significantly contribute to their total antioxidant activity. The aim of the current research was to determine the best blanching method for processing of dill prior to microwave vacuum drying based on the content of phenolic compounds, vitamin C and free radical scavenging activity. Two blanching mediums were used – water and steam, and for part of the samples microwave pretreatment was additionally used. Evaluation of vitamin C, phenolic contents and scavenging of DPPH˙ radical in dried dill was performed. Blanching had an effect on all tested parameters and the blanching conditions are very important. After evaluation of the results, as the best method for dill pretreatment was established blanching at 90 °C for 30 seconds.

***Keywords*—**blanching, microwave vacuum drying, TPC, vitamin C.

Open Science Index, Nutrition and Food Engineering Vol:6, No:4, 2012 waset.org/Publication/8819

I. INTRODUCTION

DILL (*Anethum graveolens* L.), a biennial or annual herb of the parsley family (*Apiaceae* or *Umbelliferae*), is mostly grown outdoors and harvested seasonally. Dill contains range of phytochemicals, such as vitamin C and polyphenols, which significantly contribute to their total antioxidant activity [1]. The leafy tops of dill are used in cottage cheese, potato salad, soups, sauces and salads [2], [3]. Drying is one of the oldest methods of food preservation that is used for extending dill availability throughout the year. Dehydration of herbs can be performed using different methods. Microwave drying is an efficient method for rapid dehydration and is used for aromatic plants such as dill leaves [2], [4], parsley [2], rosemary [5] etc. Our previous investigations showed that microwave vacuum drying is one of the best methods to preserve vitamin C [6] and phenolic compounds [7] in dill.

Pre-treatment is common in most processing operations to improve product safety, quality or process efficiency [8], [9]. Blanching is a thermal process designed to clean vegetable surface, reduce microbial load, slow or stop the enzyme activity, enhance the color and texture, produce structural alterations (swelling of cell walls, disruption of membranes, shrinkage of intercellular spaces, etc.), which could affect mass transport phenomena during the following processing steps [10]–[13].

Ruta Galoburda Latvia University of Agriculture, Faculty of Food Technology, Jelgava, LV-3001, Latvia (phone: 0037163005644; fax: 0037163022829; e-mail: ruta.galoburda@llu.lv)

Zanda Kruma Latvia University of Agriculture, Faculty of Food Technology, Jelgava, LV-3001, Latvia (phone: 0037163005644; fax: 0037163022829; e-mail: zanda.kruma@llu.lv).

Karina Ruse, Latvia University of Agriculture, Faculty of Food Technology, Jelgava, LV-3001, Latvia (phone: 0037163005644; fax: 0037163022829; e-mail: karina.ruse@inbox.lv).

The quality of blanched product depends significantly on the time and temperature of blanching and also on the physical and chemical properties of vegetable to be blanched. Industrial blanching processes involve treating with steam or hot water for 1–10 min at temperatures ranging from 70 to 95 °C [14], [15]. Olivera et al. [16], Zheng and Lu [17] reported that microwaves may be an effective pre-treatment process for use prior to water blanching to reduce the degradation of ascorbic acid and to accelerate the inactivation of peroxidase catalyses and thus maintain produce quality. Also in Brussels sprouts microwave pretreatment showed the higher increase in radical scavenging activity with respect to the control and an elevated level of ascorbic acid content [18].

However, since blanching is a heat treatment, changes associated with thermal processing can be expected. These include degrading and leaching of nutritive components, for example, sugars, minerals and vitamins, color change, loss of turgor in cells, due to thermal destruction of membrane integrity and partial degradation of cell wall polymers [10]. Significant reductions in the texture, color, polyphenols and antioxidant capacity were observed due to blanching of York cabbage [19]. Many authors reported significant losses in the content of vitamin C and polyphenols and decreases in antioxidative activity in vegetables after blanching [9], [20]–[22]. Selman [23] showed that the loss of vitamin C in blanched vegetables varied from 20 to 70%, while Puupponen-Pimiä et al. [24] reported 20–30% losses in brassica vegetables. Blanching reduces antioxidative activity in different vegetables; the amount of decrease depends on the length of exposure to high temperatures, the cultivar and the species. Amin and Wee Yee [25] showed that when blanching brassica vegetables for 15 min, the decrease in activity compared with the raw material was 40% in Chinese cabbage but only 4% in red cabbage.

According to Jaiswal et al. [19] minimal heat treatment in cooking practices, for example blanching, is recommended to prevent major loss of antioxidant activity and various phytochemicals. Volden et al. [26] showed the effects of blanching of red cabbage on the levels of glucosinolates, polyphenols and anthocyanins, as well as for the antioxidant potential by the ferric reducing ability power (FRAP) and oxygen radical absorbance capacity (ORAC) assays. Important changes in physicochemical and structural properties can take place in vegetable tissues after blanching, which will affect food behaviour during the final preservation stage and its storage [27].

According to Korus [9] in spite of losses in antioxidant content caused by blanching at the preliminary stage of processing, drying blanched kale leaves resulted in lower antioxidant loss. Similarly, the loss of polyphenols and vitamin C and the decrease in Trolox equivalent antioxidant activity occurring during storage was greater in non-blanched dried leaves than in blanched kale leaves. Data on the effect of blanching on physicochemical properties of dill is scarce [3].

The aim of current research was to determine the best blanching method for processing of dill prior to microwave vacuum drying based on content of phenolic compounds, vitamin C and free radical scavenging activity.

II. Materials and Methods

A. Raw materials

Dill variety 'Superdukat' was grown in the test fields of the Latvia University of Agriculture and harvested at the height of 30–35 cm. After harvest dills were washed and separated in two fractions: leaves and stems. For further analyses dill leaves were used.

B Pretreatment process

Dill leaves were water blanched at:

- 90 °C temperature for 30 seconds;
- 70 °C temperature for 60 seconds.

Dill was treated in steam at 95±1 ˚C for 30 seconds.

For microwave (MW) pretreatment 70 g of dill leaves were placed on the plate (20-cm diameter) and positioned on the turntable of the microwave variable power oven (model EMS 28405, Electrolux, Sweden). Power level 900 W was used at treatment duration 30 s. After microwave pretreatment dill was subjected to blanching in hot water or steam.

All treatments were carried out in triplicate.

The following abbreviations for the samples in this work are used, according to the method of pretreatment applied:

UB – unblached dill;
SB – steam blanched dill;
SB_MW – steam blanched dill pretreated with microwaves;
WB_70 – water blanched dill at 70 °C temperature for 60 seconds;
WB_70_MW – water blanched dill at 70 °C temperature for 60 seconds pretreated with microwaves;
WB_90 – water blanched dill at 90 °C temperature for 30 seconds;
WB_90_MW – 90 °C temperature for 30 seconds pretreated with microwaves.

C Drying

After blanching dill leaves were cut in slices 0.4±0.1 cm and dried using a microwave-vacuum drier „Musson-1" (OOO „Ingredient", St. Petersburg, Russia). Characteristic parameters of the drying program are presented in Table 1.

D Analytical methods

Dried dill (0.5 g) was extracted with 50 ml 80% ethanol solution (v / v) in water. After 2 hour extraction using magnetic stirring, samples were filtered (paper No. 89). Extracts were prepared in triplicate.

The total phenol content (TPC) of the dill extract was determined according to the Folin-Ciocalteu spectrophotometric method [28] with some modifications. To 0.5 ml of diluted extract 2.5 ml of Folin–Ciocalteu reagent (diluted 10 times with water) was added and, after 3 minutes 2 ml of Na_2CO_3 (75 g/L) was added. The sample was mixed. The control sample contained all the reaction reagents except the extract. After 30 minutes of incubation at room temperature, the absorbance was measured at 765 nm using a spectrophotometer JENWAY 6300 (Baroworld Scientifid Ltd., UK). Total phenols were expressed as gallic acid equivalents (GAE).

TABLE I
CHARACTERIZATION OF MICROWAVE VACUUM DRYING PROGRAM FOR DILL LEAVES

Parameters	Units	Values
Number of magnetrons	-	4-3-2
Pressure	kPa	12.00–14.63
Drum rotation speed	rpm	6
Drying time	min	17
Product mass	kg	1

Antioxidant activity of the plant extracts was measured on the basis of scavenging activities of the stable 2,2-diphenyl-1-picrylhydraziyl ($DPPH^{\cdot}$) radical as outlined by Yu et al. [29]. The antioxidant reaction was initiated by transferring 0.5 ml of plant extract into a sample cavity containing 3.5 ml of freshly prepared $DPPH^{\cdot}$ methanol solution (0.004 g $DPPH^{\cdot}$ to 100 ml methanol). After 30 min of incubation in the dark at room temperature, the absorbance was measured at 517 nm using a spectrophotometer JENWAY 6300.

Inhibition of $DPPH^{\cdot}$ in percent ($DPPH^{\cdot}$, %) of each extract sample was calculated from the decrease of absorbance according to relationship:

$$DPPH^{\bullet},\% = \frac{A_{blank} - A_{sample}}{A_{blank}.} \times 100 ,$$

where

A_{blank} - absorbance of control reaction (methanol–water with $DPPH^{\cdot}$);

A_{sample} - absorbance of the tested samples.

Lower absorbance of the reaction mixture indicates higher free radical scavenging activity [30].

Vitamin C was determined in dill leaves using iodometric titration method and moisture content was determined by standard method (ISO 6496:1999). All results are expressed to dry matter.

III. Results and Discussion

A. Effect on vitamin C

The content of vitamin C in dried dill blanched by various methods differed significantly ($p < 0.05$) (Fig. 1). Blanching helped to maintain vitamin C, except, in the samples blanched at 70 °C. In the study of Martinez et al. [31] also in blanched sweet pepper retention of vitamin C comparing to unblanched samples increased. It can be concluded that longer blanching time at lower temperature increase the losses of vitamin C (Fig. 1). Other authors also reported that blanching duration significantly influenced content of ascorbic acid during steam blanching and the reason is thermal degradation of ascorbic acid [32]. As vitamin C is a highly soluble substance, it is readily lost through leaching [33]. Our results show that content of vitamin C in dill after steam blanching and drying is lower comparing to water blanching at 90 °C in water, and leaching is not the most important factor that influences vitamin C content. In the current research treatment in steam at 95±1 °C for 30 seconds was used and the results correspond to the study on blanching of Swiss chard with steam at atmospheric pressure for 30 s which was sufficient to inactivate its enzymatic systems, longer blanching would result in greater losses of ascorbic acid [32]. Red peppers did not differ significantly from control sample but in the samples blanched at higher temperatures retention of vitamin C was even lower [34], but our results showed that the highest content was detected in the sample blanched at 90 °C. Although literature data showed that microwaves may be an effective pre-treatment process for use prior to water blanching to reduce the degradation of ascorbic acid [17], our results showed that only for sample blanched at 70 °C for 60 seconds beneficial effect was observed.

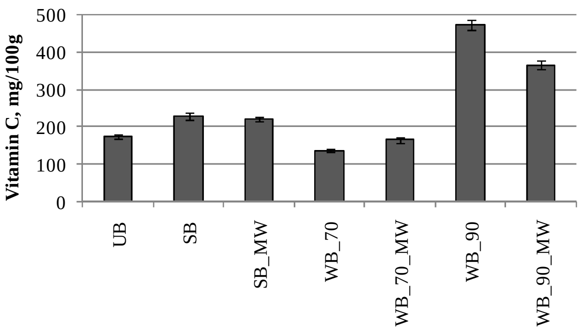

Fig. 1 Effect of pretreatment on content of vitamin C content of dried dill

In fresh dill the content of vitamin C was 581 mg/100 g. Comparison of vitamin C content in fresh and dried dill, show a decrease ranged from 19–76%, with the smallest reduction for the sample blanched in water at 90 °C. Decrease of vitamin C during microwave vacuum drying depends on program used and varies from 8% till 90% [7].

B. Effect on total phenols

Pretreatment method altered TPC in dried dill under the experimental conditions (Fig. 2).

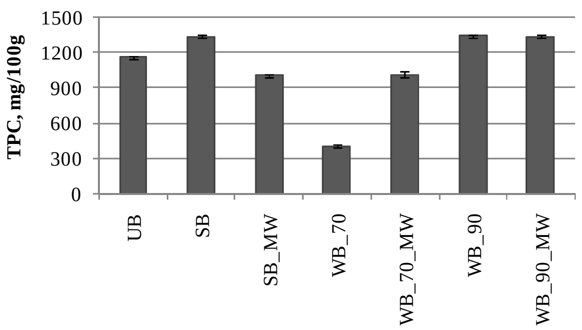

Fig. 2 Effect of pretreatment on total phenol content of dried dill

Blanching helped to maintain TPC in dill blanched in steam and in water at 90 °C temperature for 30 seconds with and without additional microwave pretreatment.

Microwave pre-treatment process influenced TPC in dried dill and it is possible to identify several contradictory trends:

- combined pretreatment of microwave and steam blanching reduced TPC in dill;
- microwave pretreatment combined with water blanching at 90 °C temperature did not influence TPC in dill;
- TPC in dill increased if water blanching at 70 °C temperature was preceded by microwave treatment.

In fresh dill TPC was 3452 mg/100 g. When compared TPC of fresh and dried dill, decrease ranged from 61 to 88%, with the smallest reduction for dill blanched in water at 90 °C both with and without microwave treatment and dill blanched in steam. Amin et al. [20] reported significant decreases in the level of polyphenols in spinach (up to 51%) after blanching. Great losses of polyphenols in vegetables during aquathermal processing are due to the dilution of these compounds in water. The dissolution of polyphenols into water depends on time of processing and size of vegetables [35].

C. Effect on DPPH˙ free radical scavenging activity

Blanching has not beneficial effect on the DPPH˙ free radical scavenging activity, but also significant differences between unblanched and blanched samples were not detected ($p > 0.05$), except dill blanched at 70 °C, where activity was significantly lower (Fig. 3).

Olivera et al. [16] reported that microwave pretreatment before water blanching of Brussel sprouts increased antiradical activity.

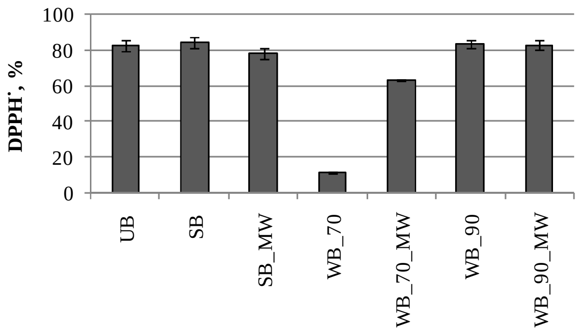

Fig. 3 Effect of pretreatment on DPPH˙ free radical scavenging activity of dried dill

Amin et al. [20] reported that less intensive aquathermal processing of leafly vegetables, such as blanching, causes a decrease of 50% in antioxidant activity, while boiling for 15 min causes as much as 82% of antioxidant compounds, including polyphenols, to escape into the water.

D. Correlation between quality parameters of dried dill

To investigate the influence of the TPC and vitamin C on the DPPH˙ free radical scavenging activity in dried dill, correlation between these parameters were determined. Results showed that there is a significant relationship between DPPH˙ scavenging capacity and TPC ($r = 0.95$) (Fig. 4.)

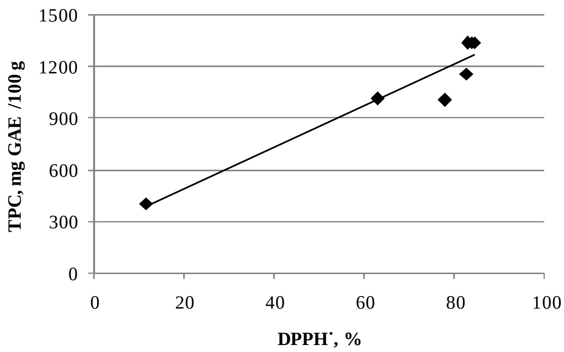

Fig. 4 Correlation between DPPH˙ free radical scavenging activity and total phenol content in dried dill

Research results of Hossain et al. [36] show importance of phenolic compounds in formation of herb antioxidant properties. In *Actinidia* fruits also DPPH˙ free radical scavenging activity highly correlated with TPC [37]. In literature contrasting data exists and in the study of Hinneburg [38] correlation between TPC and DPPH˙ scavenging as well as between TPS and iron reducing was not established.

Du et al. [37] reported that vitamin C and DPPH˙ scavenging activity exhibited strong correlation (r = 0.83), but experimental results of dried dill in the current study showed medium correlation (r = 0.52) (Fig. 5).

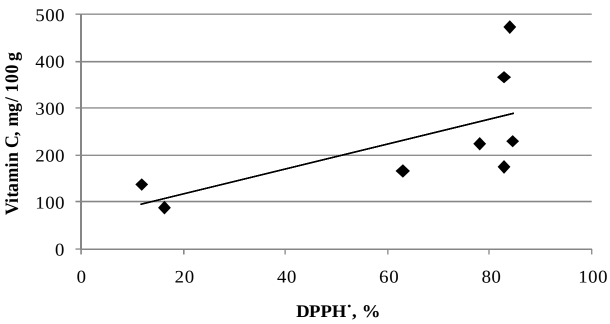

Fig. 5 Correlation between DPPH˙ free radical scavenging activity and vitamin C content in dried dill

Also Ramful [39] reported that vitamin C content of citrus fruit pulps has moderate or weak correlation with antioxidant activity measured by different methods.

To investigate the tendency of influence of blanching method on the maintaining TPC and vitamin C content in dried dill the correlation between these parameters was determined (Fig. 6).

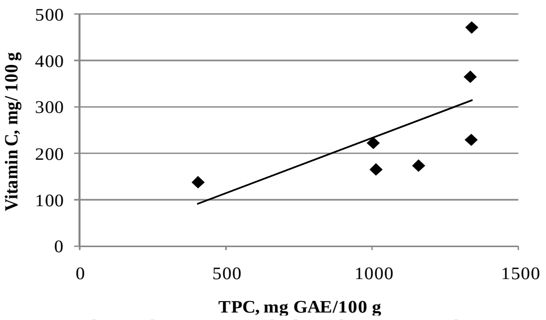

Fig. 6 Correlation between total phenol content and vitamin C content in dried dill

Medium correlation (r = 0.65) was observed meaning that blanching method has effect on the content of vitamin C and TPC in microwave vacuum dried dill.

IV. Conclusion

The present study confirms that blanching has an effect on the content of vitamin C, phenolic and scavenging of DPPH˙ radical of dried dill. Blanching is recommended to prevent the major loss of nutrients but the conditions of blanching are very important. After evaluation of TPC, vitamin C content and antiradical activity, as the best method for dill pretreatment was established blanching at 90 °C for 30 seconds. Future experiments will mainly cover the optimization of microwave pre-treatment to reduce phytochemical losses from dill in its processing.

Acknowledgment

Authors acknowledge financial support from the ESF Project “Formation of the Research Group in Food Science”, contract nr. 2009/0232/1DP/1.1.1.2.0/09/APIA/VIAA/122.

References

[1] G. G. Duthie, P. T. Gardner, J. A. M. Kyle, „Plant polyphenols: are they the new magic bullet”, *Proceedings of the Nutrition Society*, 2003, vol. 62, pp. 599–603.

[2] I. Doymaz, N. Tugrul, M. Pala, “Drying characteristics of dill and parsley leaves”, *Journal of Food Engineering*, December 2006, vol. 77, pp. 559–565.

[3] Z. Lisiewska, W. Kmiecik, J. Slupski, „Contents of chlorophylls and carotenoids in frozen dill: effect of usable part and pre-treatment on the content of chlorophylls and carotenoids in frozen dill (*Anethum graveolens* L.), depending on the time and temperature of storage”, *Food Chemistry*, March 2004, vol. 84, pp. 511–518.

[4] O. Eştürk, Y. Soysal, “Drying properties and quality parameters of dill dried with intermittent and continuous microwave-convective air treatment”, *Journal of Agricultural Sciences*, 2010, vol. 16, pp. 26–36.

[5] A. Calín-Sánchez, A. Szumny, A. Figiel, K. Jałoszyński, M. Adamski, A. A. Carbonell-Barrachina, Effects of vacuum level and microwave power on rosemary volatile composition during vacuum–microwave drying. *Journal of Food Engineering*, March 2011, vol. 103 (2), pp. 219–227.

[6] Z. Kruma, R. Galoburda, K. Dorofejeva, E. Ungure, S. Sarvi, “Effect of drying method on the content of Vitamin C in dill”, In: *Food and Nutrition, 5th Baltic conference on Food science and technology, Foodbalt-2010*, 2010, pp. 32–38.

[7] Z. Kruma, R. Galoburda, I. Gramatina, S. Muizniece-Brasava, E. Kozlinskis, L. Tomsone, “Effect of drying method on the content of phenolic compounds and antiradical activity of dill” In: *Proceedings of the 5th International conference on the quality and safety in food production chain*, 2011, Wroclaw, Poland, p. 90.

[8] S. N. Jha, S. Prasad, „Determination of processing conditions of gorgon nut (*Euryale ferox*)”, *Journal of Agricultural Engineering Research*, February 1996, vol. 63, pp. 103–112.

[9] A. Korus, “Effect of preliminary processing, method of drying and storage temperature on the level of antioxidants in kale (*Brassica oleracea* L. *var. acephala*) leaves”, *LWT - Food Science and Technology*, October 2011, vol. 44, pp. 1711–1716.

[10] K. Bahceci, A. Serpen, V. Gokmen, J. Acar, “Study of lipoxygenase and peroxidase as indicator enzymes in green beans: change of enzyme activity, ascorbic acid and chlorophylls during frozen storage”, *Journal of Food Engineering*, January 2005, vol. 66, pp. 187–192.

[11] S. M. Alzamora, M. Castro, A. Nieto, S. Vidales, D. Salvatori, “The role of tissue microstructure in the textural characteristics of”minimally processed fruits”. In: Alzamora, S.M., Tapia, M.S., Lopez-Malo, A. (Eds.), Minimally Processed Fruits and Vegetables. Aspen Publishers Inc., Gaithersburg, MD, 2000, pp. 153–171.

[12] A. Nieto, M. Castro, S. M. Alzamora, "Kinetics of moisture transfer during air drying of blanched and/or osmotically dehydrated mango", *Journal of Food Engineering*, November 2001, vol. 50, pp. 175–185.

[13] A. Patras, B. K. Tiwari, N. P. Brunton, "Influence of blanching and low temperature preservation strategies on antioxidant activity and phytochemical content of carrots, green beans and broccoli", *LWT - Food Science and Technology*, January 2011, vol. 44, pp. 299–306

[14] E. F. Morales-Blancas, V. E. Chandia, L. Cisneros-Zevallos, „Thermal inactivation kinetics of peroxidase and lipoxygenase from broccoli, green asparagus and carrots", *Journal of Food Science*, 2002, vol. 67(1), pp. 146–154.

[15] M. P. Cano, Vegetables. In: L. E. Jeremiah (Ed.), "Freezing effects on food quality". New York: Marcel Dekker, 1996, 520 p.

[16] D. F. Olivera, S. Z. Vina, C. M. Marani, R. M. Ferreyra, A. Mugridge, A. R. Chaves, R. H. Mascheroni, "Effect of blanching on the quality of Brussels sprouts (*Brassica oleracea* L. *gemmifera DC*) after frozen storage", *Journal of Food Engineering*, January 2008, vol. 84, pp. 148–155.

[17] H. Zheng, H. Lee, „Effect of microwave pretreatment on the kinetics of ascorbic acid degradation and peroxidase inactivation in different parts of green asparagus (*Asparagus officinalis* L.) during water blanching", *Food Chemistry*, October 2011, vol. 128, pp. 1087–1093.

[18] S. Z. Viña, D. F. Olivera, C. M. Marani, R. M. Ferreyra, A. Mugridge, A. R. Chaves, R. H. Mascheroni, "Quality of Brussels sprouts (*Brassica oleracea* L. gemmifera DC) as affected by blanching method", *Journal of Food Engineering*, 2007, vol. 80 (1), pp. 218–225.

[19] A. K. Jaiswal, S. Gupta, N. Abu-Ghannam, "Kinetic evaluation of colour, texture, polyphenols and antioxidant capacity of Irish York cabbage after blanching treatment", *Food Chemistry*, March 2012, vol. 131, pp. 63–72.

[20] I. Amin, Y. Norazaidah, K. I. Emmy Hainida, "Antioxidant activity and phenolic content of raw and blanched *Amaranthus* species", *Food Chemistry*, January 2006, vol. 94, pp. 47–52.

[21] P. Gębczyński, Z. Lisiewska, **"**Comparison of the level of selected antioxidative compounds in frozen broccoli produced using traditional and modified methods", *Innovative Food Science & Emerging Technologies*, Vol. 7, Issue 3, September 2006, pp. 239–245

[22] L. A. Howard, A. D. Wong, A. K. Perry, B. P. Klein, „β-Carotene and ascorbic acid retention in fresh and processed vegetables". *Journal of Food Science*, 1999, vol. 64, pp. 929–936.

[23] J. D. Selman, "Vitamin retention during blanching of vegetables", *Food Chemistry*, Vol. 49, Issue 2, 1994, pp. 137–147

[24] R. Puupponen-Pimiä, S. T. Häkkinen, M. Aarni, T. Suortti, A.-M. Lampi, M. Eurola, V. Piironen, A. M. Nuutila, K.-M. Oksman-Caldentey, „Blanching and long-term freezing affect various bioactive compounds of vegetables in different ways", *Journal of the Science of Food and Agriculture,* November 2003, Vol. 83, Issue 14, pp. 1389–1402.

[25] I. Amin, L. Wee Yee, "Effect of different blanching times on antioxidant properties in selected cruciferous vegetables", *Journal of the Science of Food and Agriculture*, 2005, vol. 85, pp. 2314–2320.

[26] J. Volden, G. I. A. Borge, G. B. Bengtsson, M. Hansen, I. E. Thygesen, T. Wicklund, "Effect of thermal treatment on glucosinolates and antioxidant-related parameters in red cabbage (*Brassica oleracea* L. ssp. capitata f. rubra)", *Food Chemistry*, August 2008, vol. 109(3), pp. 595–605.

[27] M. Gonzalez-Fesler, D. Salvatori, P. Gomez, S. M. Alzamora, "Convective air drying of apples as affected by blanching and calcium impregnation", *Journal of Food Engineering,* August 2008, vol. 87, pp. 323–332.

[28] V. L. Singleton, R. Orthofer, R. M. Lamuela-Raventós, "Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent", *Methods in Enzymology*, Vol. 299, 1999, pp. 152–178, Oxidants and Antioxidants Part A.

[29] L. Yu, J. Perret, M. Harris, J. Wilson, S. Haley, "Antioxidant Properties of Bran Extracts from "Akron" Wheat Grown at Different Locations", *Journal of Agricultural Food Chemistry*, 2003, vol. 51(6), pp. 1566–1570.

[30] G.-R. Zhao, H.-M. Zhang, T.-X. Ye, Z.-J. Xiang, Y.-J. Yuan, Z.-X. Guo, L.-B. Zhao, "Characterization of the radical scavenging and antioxidant activities of danshensu and salvianolic acid B", *Food and Chemical Toxicology*, Vol. 46, Issue 1, January 2008, pp. 73–81

[31] S. Martinez, M. Lopez, M. Gonzales-Raurich, A. Alvarez, "The effects of ripening stage and processing systems on vitamin C content in sweet peppers (*Capsicum annuum* L.), *International Journal of Food Science and Nutrition*, 2005, vol. 56 (1), pp. 45–51.

[32] M.V. Agüero, J. Pereda, S.I. Roura, M.R. Moreira, C.E. del Vallea "Sensory and biochemical changes in Swiss chard (*Beta vulgaris*) during blanching", *LWT - Food Science and Technology*, November 2005, vol. 38 (7), pp. 772-778.

[33] T. R. Arroqui, A. Rumsey, L. López, P. Virseda, "Effect of different soluble solids in the water on the ascorbic acid losses during water blanching of potato tissue", *Journal of Food Engineering*, February 2001, vol. 47 , pp. 123–126.

[34] S. M. Castro, J. A. Saraiva, J. A. Lopes-da-Silva, I. Delgadillo, A. Van Loey, C. Smout, M. Hendrick "Effect of thermal blanching and of high pressure treatments on sweet green and red bell pepper fruits (*Capsicum annuum* L.)", *Food Chemistry*, April 2008, vol. 107(4), pp. 1436–1449.

[35] E. Sikora, E. Cieślik, T. Leszczyńska, A. Filipiak-Florkiewicz, P. Pisulewski "The antioxidant activity of selected cruciferous vegetables subjected to aquathermal processing", *Food Chemistry*, March 2008, vol. 107 , pp. 55–59.

[36] M. B. Hossain, C. Barry-Ryan, A. B. Martin-Diana, N. P. Brunton, "Effect of drying method on the antioxidant capacity of six Lamiaceae herbs", *Food Chemistry*, November 2010, Vol. 123, Issue 1, pp. 85–91.

[37] G. Du, M. Li, F. Ma, D. Liang, "Antioxidant capacity and the relationship with polyphenol and Vitamin C in Actinidia fruits", *Food Chemistry*, March 2009, vol. 113 (2), pp. 557–562.

[38] I. Hinneburg, H. J. D. Dorman, R. Hiltunen, "Antioxidant activities of extracts from selected culinary herbs and spices", *Food Chemistry*, Vol. 97, Issue 1, July 2006, pp. 122–129.

[39] D. Ramful, E. Tarnus, O. I. Aruoma, E. Bourdon, T. Bahorun, „Phytophenolic, Vitamin C composition and antioxidant propensities of Mauritian citrus fruit pulps". *Food Research International*, Vol. 44, Issue 7, August 2011, pp. 2088-2099, Exotic Fruits: their Composition, Nutraceutical and Agroindustrial Potential.

Ruta Galoburda, Dr. sc. ing., professor at the Latvia University of Agriculture, Faculty of Food Technology, was born in Latvia, Vainode in 1959. Scientific interests – effect of processing technologies on food quality, development of new food products. She has 64 scientific publications and participated in 10 different projects. At present R. Galoburda is a leader of the project „Sustainable use of local agricultural resources for development of high nutritive value food products (Food)" within the National Research Programme "Sustainable use of local resources (earth, food, and transport) – new products and technologies (NatRes)" (2010.-2013.)

Zanda Kruma, Dr. sc. ing., leader researcher at the Latvia University of Agriculture, Faculty of Food Technology, was born in Latvia, Aizpute in 1980. In 2008 she defended PhD thesis and obtained doctoral degree in food science. Main topics of research: biologically active substances in foodstuffs, food aroma analysis. She has 22 scientific publications and participated in 6 different projects.

Karina Ruse, PhD student in Latvia University of Agriculture, Faculty of Food Technology