JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2021, *27*(4-Supplement), 469-472

Journal of Agroalimentary Processes and Technologies

Study on the nutritional potential of some rice assortments

Liana Maria Alda[1], Despina-Maria Bordean[1,3], Ionut Adelin Bobiti[1], Simion Alda[2*], Teodor Cristea[2], Daniela Nicoleta Scedei[2], Laura Radulescu[1], Diana Moigradean[1], Ariana Velciov[1,3]

[1]Faculty of Food Engineering, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Calea Aradului no. 119, 300645 Timisoara, Romania,
[2]Faculty of Horticulture and Forestry, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Calea Aradului no. 119, 300645 Timisoara, Romania
[3]Research Center for"Food Science", Faculty of Food Engineering, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" – Timişoara, Calea Aradului 119, 300645 – Timişoara, Romania

Abstract

Rice have a high nutritional value such as carbohydrate, fiber, protein, fat, vitamins as well as minerals and fatty acids.About 20% of the world's rice is partially boiled. Parboiling has a high impact on the texture and nutritional characteristics of cooked rice.The goal of this study was to evaluate the nutritional potential of different assortments of rice: enriched or unenriched, raw or parboiled. For the nutritional characterization of rice varieties, we used USDA and FoodB databases nutritional data and the analysis methods were the PAST and MVSP statistical programs. Our results shows that the improvement of rice strongly influences the nutritional characteristics of rice after boiling.

Keywords: *Oryza sativa L.*, parboiling, statistical analysis

1. Introduction

Rice (*Oryza sativa L.*) have a high nutritional value such as carbohydrate, fiber, protein, fat, vitamins as well as minerals and fatty acids [14]. It provides high carbohydrates, which account for more than 50% of daily calorie intake and consumed by more than 67% of the world's population [2]. Rice is a rich source of carbohydrates; includes a low amount of protein and fat, as well as a source of B-complex vitamins such as niacin, riboflavin and thiamine [5]. Rice carbohydrates are primarily starch, consisting of amylose and amylopectin. Rice grains contain 12% water, 75-80% starch, and only 7% protein. Rice protein due to the higher concentration of lysine, is highly digestible (93%), with a high biological value (74%) [9].

Minerals such as calcium, magnesium and phosphorus along with a quantity of copper, iron, manganese and zinc are present in rice [12,13].

In addition to the nutritional components, many phytochemicals present in rice have been identified as bioactive compounds that have many high biological activities, such as antioxidant, anticancer, antidiabetic and anti-inflammatory properties [7,8,14].

These biologically active compounds are more concentrated in rice bran and are beneficial to health [6].

Rice bran also includes nutritional components in addition to bioactive compounds. These are: cellulose, hemicellulose, pectin, arabinoxylan, lignin, β-glucan, polyphenols, γ-orzanol, β-sitosterol, vitamin B9, vitamin E, micronutrients and essential amino acids [7].

About 20% of the world's rice is partially boiled. Parboiling has a considerable impact on the texture and nutritional characteristics of cooked rice. This hydrothermal treatment involves softening, heating and drying the rice and is performed on either hard rice or brown rice. Parboiled rice is firmer, less sticky and more nutritious than its raw counterpart. Parboiled rice has a darker color than raw rice and a slightly different flavor [1,4, 3,10].

The reserches made by Meresa, A., *et al.* [11], shows that parboiling increased the head rice yield, water uptake ratio and enhanced the overall quality of the rice. A lot of rice properties can be obtained by combining different parboiling methods with variety of rice assortments [19].

Corresponding authors: aldasimion@usab-tm.ro

2. Material and Methods

For the study case were used USDA and FoodB nutritional databases regarding four assortments of white long-grain rice:

- raw, unenriched,
- parboiled, unenriched,
- raw, enriched,
- parboiled, enriched.

The nutritional values of rice varieties were analyzed using PAST and MVSP statistical programs, in order to establish the changes due to boiling process in the case of unenriched / enriched rice.

3. Results and discussion

As a result of the application of boiling with heat treatment, it is observed that the changes are smaller in the case of improved rice compared to unimproved rice (logarithmic variations of improved rice are smaller if heat treatment is applied compared to unimproved rice).

The correlations in Table 1 show that the improvement of rice strongly influences the nutritional characteristics of rice after boiling.

Table 1.Correlations between IB, NB and TT

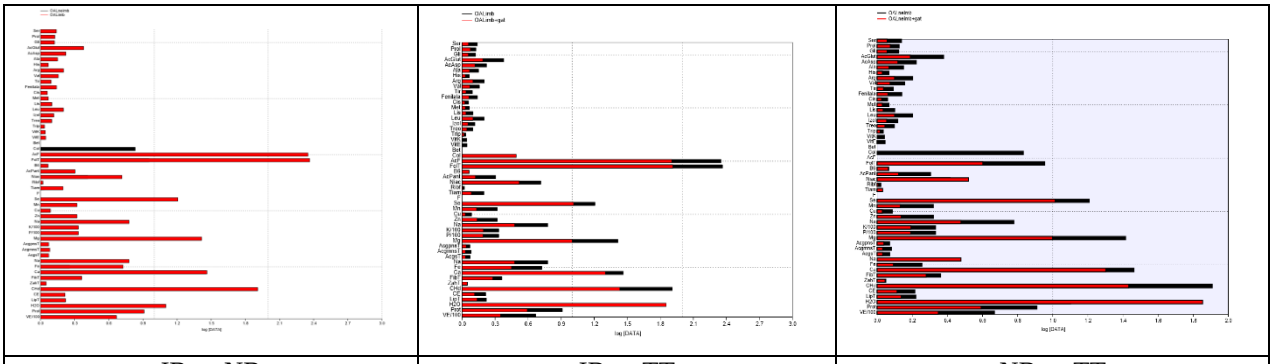
0	NB	NB- T	IB	IB-T
OALneimb	0	3.72E-40	3.82E-38	1.78E-37
OALneimb+gat	0.98748	0	5.61E-54	6.47E-57
OALimb	0.98479	-0.99669	0	2.02E-67
OALimb+gat	-0.98377	0.99755	0.99909	0

The main nutritional values of long grain white rice are shown in Table 2. From this table and figure 1, it can be seen that the improvement is due to changes in the amino acids content.

Table 2.Nutritional values of the white long-grain rice assortments (100g)

	Symbol	Rice, raw, unenriched [17]	Rice, parboiled, unenriched [18]	Rice, raw, enriched [15]	Rice,parboile, enriched [16]
Protein (g)	Prot	7.130	2.910	7.130	2.910
Water (g)	H2O	11.620	70.360	11.620	70.360
Total lipid (fat) (g)	LipT	0.660	0.370	0.660	0.370
Ash (g)	CE	0.640	0.300	0.640	0.300
Carbohydrate (g)	CHd	79.950	26.050	79.950	26.050
Sugars, total (g)	ZahT	0.120	0.110	0.120	0.110
Fiber, total (g)	FibT	1.300	0.900	1.300	0.900
Calcium (mg)	Ca	28.000	19.000	28.00	19.000
Iron (mg)	Fe	0.800	0.240	4.310	1.810
Fatty acids, total saturated (g)	AcgsT	0.180	0.074	0.180	0.074
Fatty acids, total monounsaturated (g)	AcgmnsT	0.206	0.074	0.206	0.074
Fatty acids, total polyunsaturated (g)	AcgpnsT	0.177	0.091	0.177	0.091
Magnesium (mg)	Mg	25.000	9.000	25.000	9.000
Phosphorus (mg/100)	P/100	1.150	0.550	1.150	0.550
Potassium (mg/100)	K/100	1.150	0.560	1.150	0.560
Sodium (mg)	Na	5.000	2.000	5.000	2.000
Zinc (mg)	Zn	1.090	0.370	1.090	0.370
Copper (mg)	Cu	0.220	0.070	0.220	0.070
Manganese (mg)	Mn	1.088	0.354	1.088	0.354
Selenium (µg)	Se	15.100	9.300	15.100	9.300
Thiamin (mg)	Tiam	0.070	0.074	0.576	0.212
Riboflavin (mg)	Ribf	0.049	0.019	0.049	0.019
Niacin (mg)	Niac	1.600	2.309	4.192	2.309
Pantothenic acid (mg)	AcPant	1.014	0.323	1.014	0.323
Vitamin B-6 (mg)	B6	0.164	0.156	0.164	0.156
Folate, total (µg)	FolT	8.000	3.000	231.000	81.000
Folic acid (µg)	AcF	0.000	0.000	223.000	79.000
Vitamin E (mg)	VitE	0.110	0.010	0.110	0.010
Vitamin K (µg)	VitK	0.100	0.000	0.100	0.000
Tryptophan (g)	Trip	0.083	0.039	0.083	0.040
Threonine (g)	Treo	0.255	0.107	0.255	0.105
Isoleucine (mg)	Izol	0.308	0.133	0.308	0.131
Leucine (mg)	Leu	0.589	0.257	0.589	0.254
Lysine (mg)	Lis	0.258	0.082	0.258	0.083
Methionine (mg)	Met	0.168	0.070	0.168	0.071
Cystine (mg)	Cis	0.146	0.060	0.146	0.059
Phenylalanine (mg)	Fenilala	0.381	0.153	0.381	0.154
Tyrosine (mg)	Tir	0.238	0.086	0.238	0.084

Valine (mg)	Val	0.435	0.185	0.435	0.182
Arginine (mg)	Arg	0.594	0.256	0.594	0.252
Histidine (mg)	His	0.168	0.07	0.168	0.072
Alanine (mg)	Ala	0.413	0.169	0.413	0.168
Aspartic acid (mg)	AcAsp	0.670	0.313	0.670	0.308
Glutamic acid (mg)	AcGlut	1.389	0.545	1.389	0.541
Glycine (mg)	Gli	0.325	0.140	0.325	0.139
Proline (mg)	Prol	0.335	0.187	0.335	0.187
Serine (mg)	Ser	0.375	0.141	0.375	0.142



IB vs NB	IB vs TT	NB vs TT

Figure 1.Graphic representation of differences in rice as a result of improvement and heat treatment
Legend: IB = enriched rice*; NB*= unenriched rice*; TT= thermal treatment (parboiling)*

If we apply the cluster analysis we can highlight that the maximum influence is given by the improvement of rice, this improvement being the characteristic that strongly influences its boiling behavior, and implicitly the variations of the nutritional values.

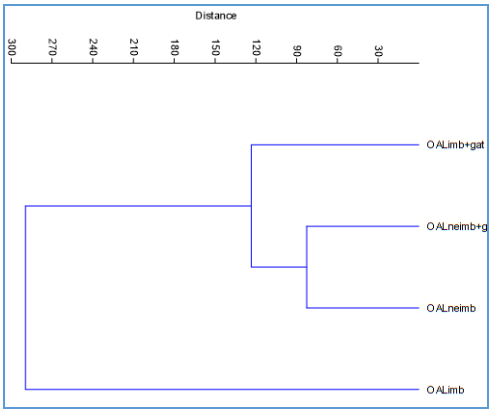


Figure 2. Cluster data analysis
Legend: *OALneimb* = rice, raw, unenriched*; OALneimb+gat* = rice, parboiled, unenriched*; OALimb* = rice, raw, enriched*; OALimb+gat* = rice, parboiled, enriched

This aspect is highlighted by the main component analysis (PCA).

The cluster analysis was performed using the associated group algorithm and the Euclidean distance function (figure 2), obtaining a 0.9369 correlation coefficient.

The PCA graphical representation is shown in figure 3.

The PCA analysis shows a high variance of approximately 92.46% on component 1 and 7.52% on component 2 (table 3), at a Joliffe cut off: 5747.

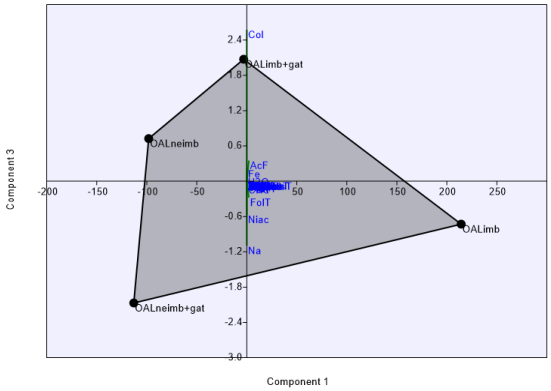


Figure 3. PCA representation of the nutritional characteristics of rice assortments
Legend: *OALneimb* = rice, raw, unenriched*; OALneimb+gat* = rice,parboiled,unenriched*; OALimb* = rice, raw, enriched*; OALimb+gat* = rice, parboiled, enriched

Table 3.Distribution of variance on component axes PC1 and PC2

PC	Eigenvalue	% variance
1	22775.1	92.465
2	1852.86	7.5224
3	3.2127	0.013043

The effect of heat treatment on rice grains is shown in Figure 4. This figure was constructed using PCA and the Euclidean biplot graphical representation after transforming the value data into square roots and standardization.

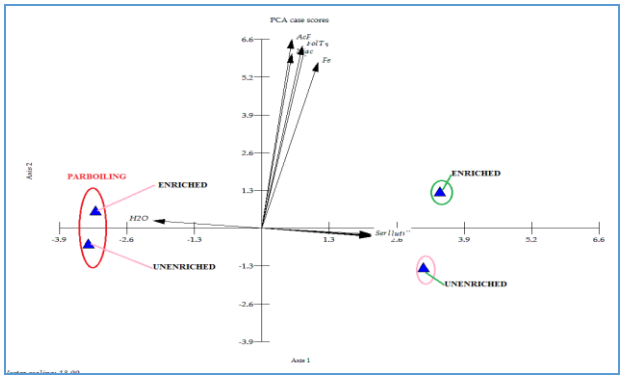


Figure 4.The effect of parboiling process on rice assortments

Figure 4 shows that the parameter that most influences the cooking process of rice is directly proportional to the amount of water.

It is noted that in the case of improved rice a smaller amount of water is sufficient, while in the case of unimproved rice a higher amount of water is recommended for cooking.

4.Conclusions

Following the application of the cluster analysis, the maximum influence is given by the improvement of rice, referred as the characteristic that strongly influences rice's boiling behavior, and implicitly the variations of the nutritional values.

This aspect was highlighted also by applying the Principle Component Analysis.

Acknowledgements: This work was supported by proving the equipment's of the Faculty of Food Engineering Timişoara – "*Food Science*"- Research Center.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

References

1. Bhattacharya, K.R., Parboiling of rice. In: Champagne, E.T. (Ed.), *Rice: Chemistry and Technology*, third ed. American Association of Cereal Chemists,St. Paul, MN, USA, **2004**, pp. 289–348
2. Buggenhout, J., Brijs, K., Celus, I., & Delcour, J. A., The breakage susceptibility of raw and parboiled rice: A review. *Journal of Food Engineering* **2013**, *117*(3), 304-315
3. Delcour, J.A., Hoseney, R.C., Rice and oat processing. *Principles of Cereal Science and Technology*, third ed. AACC International, **2010**, pp.149–160
4. Derycke, V., Vandeputte, G.E., Vermeylen, R., De Man, W., Goderis, B., Koch, M.H.J., Delcour, J.A., Starch gelatinization and amylose-lipid interactions during rice parboiling investigated by temperature resolved wide angle X-ray scattering and differential scanning calorimetry,*Journal of Cereal Science* **2005**, *42*(3), 334–343
5. Fresco, L. , Rice is life. Journal of Food Composition and Analysis **2005**, *18*, 249–253
6. Ghasemzadeh, A., Karbalaii, M. T., Jaafar, H. Z. E., & Rahmat, A. Phytochemical constituents, antioxidant activity, and antiproliferative properties of black, red, and brown rice bran,*Chemistry Central Journal* **2018**, *12*(1), 17
7. Goffman, F. D., & Bergman, C. J. , Rice kernel phenolic content and its relationship with antiradical efficiency. *Journal of the Science of Food and Agriculture* **2004**, *84*, 1235–1240
8. Goufo, P., & Trindade, H., Rice antioxidants: Phenolic acids, flavonoids, anthocyanins, proanthocyanidins, tocopherols, tocotrienols, γ-oryzanol, and phytic acid. *Food Sciences and Nutrition* **2014**, *2*(2), 75–104
9. Juliano, B. O. , Nutritional value of rice and rice diets. *Rice in human nutrition* 1993, pp. 61–84. Rome, Italy: Pub. International Rice Research Institute (IRRI), Philippines and Food and Agriculture Organization of the United Nations
10. Manful, J.T., Grimm, C.C., Gayin, J., Coker, R.D., Effect of variable parboiling on crystallinity of rice samples. *Cereal Chemistry* **2008**, *85* (1), 92–95
11. Meresa, A., Demissew, A., Yilma, S., Tegegne, G., & Temesgen, K. Effect of parboiling conditions on physical and cooking quality of selected rice varieties. *International Journal of Food Science*, **2020**. https://doi.org/10.1155/2020/8810553
12. Verma, D. K., & Srivastav, P. P., Proximate composition, mineral content and fatty acids analyses of aromatic and non-aromatic Indian rice. *Rice Science*, **2017**, *24*(1), 21–31
13. Verma, D. K., Srivastav, P. P., & Mohan, M., Nutritional quality evaluation of different rice cultivars. In D. K. Verma, & P. P. Srivastav (Eds.). *Agronomic ricepractices and post-harvest processing for production and quality improvement of rice*, **2018**
14. Verma, D. K., & Srivastav, P. P., Bioactive compounds of rice (Oryza sativa L.): review on paradigm and its potential benefit in human health. *Trends in Food Science & Technology* **2020**, *97*, 355-365
15. https://fdc.nal.usda.gov/fdc-app.html#/food-details/168877/nutrients
16. https://fdc.nal.usda.gov/fdc-app.html#/food-details/169708/nutrients
17. https://fdc.nal.usda.gov/fdc-app.html#/food-details/169756/nutrients
18. https://fdc.nal.usda.gov/fdc-app.html#/food-details/169759/nutrients
19. https://www.sciencedirect.com/topics/food-science/parboiling