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STUDIES ON PHYTIC ACID, AROMA AND LEACHATES OF BASMATI RICE (*ORYZA SATIVA L.*) DURING STORAGE

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Introduction

Rice, the major staple cereal food in many parts of the world, is used as a supplementary food in many countries. It is a common practice to age the freshly harvested rice at least for six months before consumption. Storage induced aging has both desirable and undesirable effects on the end products, depending upon storage conditions and rice variety[1]. Aromatic rice has been very popular and command a higher price in the rice market than non aromatic rice varieties. Aroma is the result of genetic factors and environment[2,3].

Phytic acid has been regarded as the primary storage form of both phosphate and inositol in almost all seeds[4]. It is a strong site for trace minerals having strong chelating power[5]. The nutritional contribution of the plant foods could be significantly increased,

TABLE I

Influence of Storage Period on Phytic Acid Content of Basmati Rice

Particulars	Fresh	4 months stored	8 months stored	12 months stored
Pusa Basmati-1	65.99 ± 0.17	63.82 ± 0.36	62.77 ± 0.93	62.97 ± 0.19
Haryana Basmati-1	63.66 ± 0.66	62.85 ± 0.28	62.60 ± 0.21	61.92 ± 0.18
Basmati 370	65.70 ± 0.58	64.52 ± 0.57	63.94 ± 0.53	63.53 ± 0.54
PR 106	73.69 ± 0.44	72.52 ± 0.33	71.67 ± 0.54	71.48 ± 0.55
Taraori Basmati	68.52 ± 0.31	66.87 ± 0.57	66.79 ± 0.19	64.53 ± 0.51
HKR 91-406	67.53 ± 0.43	65.60 ± 0.44	66.33 ± 0.09	64.22 ± 0.42
HKR 92-401	70.70 ± 0.21	68.72 ± 0.47	68.62 ± 0.30	66.99 ± 0.23
HKR 93-401	68.60 ± 0.43	67.46 ± 0.24	66.53 ± 0.59	64.53 ± 0.55
HKR 93-402	69.94 ± 0.28	68.71 ± 0.46	68.37 ± 0.11	65.35 ± 0.62
HKR 91-455	68.46 ± 0.50	67.04 ± 0.81	67.47 ± 0.64	65.95 ± 0.23
HKR 92-455	68.55 ± 0.24	67.04 ± 0.54	66.42 ± 0.05	65.95 ± 0.23
HKR 92-447	68.67 ± 0.36	67.03 ± 0.40	66.43 ± 0.45	65.29 ± 0.98
Mean	68.21	66.85	66.49	65.23
SEm ±	0.29	0.34	0.33	0.36
CD 5%	0.91	1.07	1.03	1.15

Each value is an average of two estimations

if the phytates in these foods were reduced[6]. Leakage of electrolytes seems to be associated with aging phenomenon[7,8]. Electrical conductivity of leachates varies due to differences in grain structure, permeability of membrane packaging and/ or differences in composition of seed and endosperm and interaction among various constituents of seed. This study reports changes in phytic acid, aroma and electrical conductivity of leachates during one year of storage in twelve basmati genotypes raised at regional rice research station, Kaul (Kaithal) of the University during 1996.

Materials and Methods

The present investigation was carried out on twelve rice genotypes namely Pusa Basmati-1, Haryana Basmati-1, Basmati 370, Taraori Basmati, HKR 91-406, HKR 92-401, HKR 93-401, HKR 93-402, HKR 91-455, HKR 92-446, HKR 92 - 447, representing basmati and PR-106, a non basmati type. Paddy seeds of these genotypes were procured from CCS Haryana Agricultural University, Rice Station, Kaul during December 1996 and were dehusked and depolished uniformly utilising the locally existing facilities available. One kg sample of each genotype was fumigated in air tight circular steel container of 20kg capacity with one tablet of aluminum phosphide for three days as per the instructions outlined in package of practices of the University[10]. The rice grains were cleaned for dust, stones, broken seeds and other foreign material. Rice grains (250g) of

TABLE II

Effect of Storage on Aroma Components of Basmati Rice (mg $KMNo_4$/100 g dry weight)

Genotype	VRS (Fresh)	VRS (4 months aged)	VRS (8 months aged)	VRS (12 months aged)
Pusa Basmati-1	59.85 ± 0.18	59.41 ± 0.09	58.97 ± 0.09	57.61 ± 0.04
Haryana Basmati-1	58.59 ± 0.17	58.23 ± 0.05	57.99 ± 0.05	56.79 ± 0.05
Basmati 370	58.94 ± 0.22	58.65 ± 0.08	58.24 ± 0.13	56.99 ± 0.12
PR 106	13.37 ± 0.21	12.96 ± 0.18	12.39 ± 0.09	11.82 ± 0.08
Taraori Basmati	63.93 ± 0.04	63.40 ± 0.53	62.53 ± 0.50	61.88 ± 0.09
HKR 91-406	57.65 ± 0.09	57.22 ± 0.15	56.66 ± 0.13	55.13 ± 0.17
HKR 92-401	57.42 ± 0.13	57.14 ± 0.09	56.55 ± 0.34	55.21 ± 0.05
HKR 93-401	57.07 ± 0.18	56.87 ± 0.04	56.28 ± 0.13	55.02 ± 0.05
HKR 93-402	56.82 ± 0.17	56.21 ± 0.08	56.00 ± 0.09	54.53 ± 0.73
HKR 91-455	56.79 ± 0.13	55.47 ± 0.31	54.47 ± 0.51	53.44 ± 0.45
HKR 92-455	57.71 ± 0.17	57.25 ± 0.18	56.04 ± 0.21	55.18 ± 0.11
HKR 92-447	63.07 ± 0.18	62.03 ±0.12	56.00 ± 0.18	54.21 ± 0.13
Mean	55.10	54.57	53.51	52.32
SEm ±	0.12	0.15	0.18	0.19
CD 5%	0.37	0.46	0.57	0.59

Each value is an average of two estimations

all the genotypes were stored in the dark for one year at room temperature. During one year of aging, rice samples were removed after four, eight and 12 months. Fresh and aged samples were ground to pass 80 mesh sieve having 0.2 mm particle size using Udytec Cyclone sample mill. Phytic acid was estimated by the method of Davies and Reid[11]. Rice aroma was determined as per the method described by Mahindru[12] and results were expressed as volatile reducing substances (VRS) in terms of mg $KMNo_4$/100g dry weight. Electrical conductivity of leachates was monitored[13] by immersing five grams of whole rice grains in 10ml of deionized water and kept at room temperature for one hour. The leachates were transferred to 50ml volumetric flask and volume was made upto the mark with deionized water. Systomix conductivity bridge model 305 was used to determine specific conductance and results were expressed as $Ohm^{-1}cm^{-1}$.

Results and Discussion

Phytic acid at four, eight and 12 months of rice aging has been shown in Table I. Haryana Basmati-1 and PR 106 differed significantly from the other genotypes. Pusa Basmati-1, Haryana Basmati-1 and Basmati 370 contained low levels of phytic acid. Reduction in phytic acid was noticed after four, eight and 12 months of storage compared to fresh rice. The mean per cent reduction were about 2.0, 2.5 and 4.4 per cent after 4, 8, and 12 months, respectively. The perusal of data also revealed that

TABLE III

Variations in Specific Conductance ($ohm^{-1}cm^{-1}$) of Leachates of Basmati Rice During Storage

Genotype	Fresh	4 months aged	8 months aged	12 months aged
Pusa Basmati-1	360 ± 14.14	470 ± 14.14	565 ± 21.21	690 ± 14.14
Haryana Basmati-1	360 ± 28.28	460 ± 14.14	555 ± 21.21	690 ± 28.28
Basmati 370	375 ± 21.21	465 ± 07.07	575 ± 21.21	705 ± 21.21
PR 106	455 ± 21.21	535 ± 49.50	670 ± 28.28	790 ± 14.14
Taraori Basmati	395 ± 21.21	500 ± 14.14	600 ± 28.28	730 ± 28.28
HKR 91-406	380 ± 14.14	505 ± 35.36	585 ± 21.21	720 ± 28.28
HKR 92-401	440 ± 14.14	560 ± 14.14	650 ± 14.14	785 ± 21.21
HKR 93-401	425 ± 21.21	545 ± 21.21	635 ± 21.21	760 ± 14.14
HKR 93-402	425 ± 7.07	555 ± 21.21	650 ± 28.28	775 ± 21.21
HKR 91-455	425 ± 35.56	535 ± 21.21	625 ± 21.21	765 ± 35.26
HKR 92-455	410 ± 28.28	525 ± 21.21	625 ± 35.36	755 ± 35.36
HKR 92-447	405 ± 35.36	525 ± 21.21	610 ± 28.28	745 ± 35.36
Mean	404.58	515.00	612.08	742.50
SEm ±	16.52	16.72	17.50	18.37
CD 5%	52.05	53.05	55.14	57.89

Each value is an average of two estimations

throughout the entire storage period, Haryana Basmati-1 contained the lowest level of phytic acid and PR 106 the highest. Mameesh and Tomar[14] observed phytic acid concentration of 60mg/100g in Basmati, 248mg/100g in American, 165mg/100g in Egyptian and 90mg/100g in Peshwar whereas our results depicted an average value of 68.21 mg/100g in fresh samples. The present values are not akin to the findings of Toma and Tabekhia[15], Aremu[16] and Ravindran *et al*[17]. The possible governing reasons for disagreement could be differences in genotypes, agroclimatic conditions, processing technology, storage conditions and the techniques used for analysis. The observed decline in phytic acid during storage may be due to its breakdown by endogenous phytase. Similar decrease in phytate levels were observed by Narayan *et al*[18] in soyabean, Larsson and Sandberg[19] in oats and Ebine[20] in rice.

Table II summarises the aroma of 11 basmati and one non basmati rice at 0, 4, 8 and 12 months of storage. The aroma has been expressed as VRS which is defined as mg $KMNo_4$ required to oxidise aroma released by 100g rice. Taraori Basmati recorded highest (53.93) and PR 106 (13.37) the lowest VRS that is significantly different from other genotypes. The mean deserved was 55.10. VRS value gradually declined at 4, 8 and 12 months of storage in comparison to fresh rice that amounts to 1.0, 2.9 and 5.1 per cent respectively. After 12 months of storage, the commercial genotypes namely Taraori Basmati, Pusa Basmati-1, Haryaana Basmati-1 and Basmati 370 retained higher VRS value than the remaining genotypes. Mahindru[12] reported different VRS value for several rice varieties namely 73.9 to 95.2 for Basmati, 64.2 for Dhubraj, 71.6 for Chinnar (all scented) and 35.4 for non scented. The present values for Taraori Basmati and HKR 92-447 of fresh rice grains are comparable to above values. The nonagreement of results in remaining genotypes may be attributed to differences in genetic make up of research material in question. The present trend of decrease in aroma during storage aging of basmati rice are in conformity to those of Ahuja *et al*[21]. During storage, the desirable volatile substances breakdown and diffuse out of rice grains into the environment[22,23] that also support the present results.

Changes in leakage of electrolytes following aging are presented in Table III. In fresh rices, EC of electrolyte leachates in the imbibing medium varied from 360 to 455 with a mean of 404.58 $ohm^{-1} cm^{-1}$; the PR 106 exhibited the maximum. Significant lower EC values were indicated in leachates of pusa Basmati-1, Haryana Basmati-1, Basmati 370 and HKR 91-406 compared to PR 106 in aged rices throughout storage period. Results also revealed that loss of electrolytes increased with duration of aging and the respective mean increment in EC values after 4,8 and 12 months were 21.4, 33.9 and 45.5 per cent. Yogalakshmi *et al*[3] observed high leakage of electrolytes in eight months old rice hybrid and its perennial lines as compared to fresh rice. Several researchers[7,8,24] also linked loss of electrolytes to aging phenomenon in seeds. The differential behaviour of different rice genotypes for electrolytes loss and increase in EC values of leachates may be attributed to variances in grain structure, permeability of membrane packaging and / or differences in composition of seed and endosperm and interaction among various constituents of seed that might have altered during aging. Aged seeds experienced fragility of mitrochondria and increase protease activity responsible for degradation of vital structure and soluble proteins of organelles membranes, nuclear proteins, ribosomes and enzymes. Similar explanations were also earlier claimed[9,25].

Summary and Conclusion

Eleven basmati and one non basmati rice genotypes were evaluated for phytic acid, aroma and leachates loss during one year of storage. Fresh, 4, 8 and 12 months aged rice revealed that both phytic acid and aroma declined continuously during storage but EC values of leachates increased regularly with storage period. The mean reduction in phytic acid was 2.0, 2.5 and 4.4 per cent after 4, 8 and 12 months in comparison to fresh rice whereas the loss in aroma corresponded to 1.0, 2.9 and 5.1 per cent and increase in EC of leachates amounts to 21.4, 33.9 and 45.5 per cent, respectively. PR 106 non-scented was found to contain maximum phytic acid and specific conductance of leachates but indicated low VRS values pertaining to aroma throughout aging of rice during storage.

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