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Thermal and cooking quality of rice (*Oriza sativa*) varieties grown under salt stress condition

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Abstract
The present investigation entitled the Thermal and cooking quality of Rice (*Oriza sativa*) grown under salt stress condition, was conducted at Department of Agricultural Biochemistry, C.S. Azad University of Agriculture and Technology, Kanpur during the year 2018-2019 and 2019-2020. The experiment was laid down with using complete Randomized Design (CRD) With ten Promising salt Tolerant Rice Varieties *viz*. CSR-10, CSR-13, CSR-23, CSR-27 CSR-30, NDR-97, CSAR-1604, CSAR-1610, CSAR-1620, CSAR-1572. The result of an experiment on various thermal quality of salt tolerant rice varieties among which CSR-30 have high kernel elongation (12.36mm), kernel elongation ratio (1.53mm), and Alkali spreading value (6.1) while water uptake is high in NDR-97 (426.5ml) and Volume expansion high in CSAR-1610(13.07mm).In Cooking quality CSR-30 and CSR-27 have better quality of aroma, Softness and have less stickiness over all Salt tolerant rice varieties. almost all varieties are long slender in appearance but CSR-10 are small slender.

Keywords: Salt tolerant rice, thermal quality, cooking quality, aroma, softness

Introduction
Rice (*Oryza sativa* L) belongs to the family Poaceae. The basic chromosome number of rice is n=12. The species can be either diploid or tetraploid. In this respect, *Oryza sativa* L. and Oryza glaberrima L both are diploid species (2n= 24) Brar and Khush (2003) [3].
Rice plays an important role in world economy, being the staple food for two-thirds of its population. Although since the mid 1960S, plant type based high yielding varieties have been developed and released, which brought a quantum jump in production and productivity, yet for the acceptance and spread of varieties, grain quality has become an important criteria after yield (Shobha Rani *et al*, 2006) [17].
Various abiotic stresses including high or low temperature, water scarcity, high salinity and heavy metals exert drastic antagonistic effects on crop metabolism and thereby plant growth, development and ultimately crop productivity. Amongst these, soil salinity is a major factor limiting the crop production globally (Kumar *et al.* 2010) [11]. Salinity is a common abiotic stress that severely limits crop growth and development, productivity and causes the continuous loss of arable land, which results in desertification in arid and semi-arid regions of the world (Pons *et al*., 2011). It is estimated that more than 800 million hectares of land throughout the world are adversely affected by high salinity (Munns and Tester, 2008) [13].

Method and Materials
Present investigation was conducted during 2018-19 and 2019-20 under the lab experiment in the laboratories of the Department of Agricultural Biochemistry at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002 (Uttar Pradesh). The experiment was laid down with using complete Randomized Design (CRD)

Water uptake (WU) ml/100 g
Water uptake capacity was determined by Hogan and Plank (1958) [7] method. 100 g rice was taken and added 10 ml of water at 77 ^{0}C.

Volume expansion on cooking
Kernel length after cooking was determined by with the help of thread Vernier Calliper's scale and measured in mm. The expansion of rice after cooking expressed in terms of original volume is called volume expansion which determined as described by Halick and Kelly (1959) [6].

Elongation and K/E ratio
Elongation ratio was determined on the basis of ratio of kernel length after and before cooking of rice. The kernel elongation ratio was computed as follows: (Juliono, 1971) [9]
K.E.R. = Kernel elongation of cooked rice (mm) / Kernel length (mm)

Alkali spreading value
10 milled rice kernels were placed in 10 ml 1.7 per cent KOH in shallow containes and arrange them so that they don't touch. Let it stand for 23 hours at 30 ^{0}C and score for spreading was determined by the method outline by Little *et al*. (1958) [12]

Cooking Quality
Appearance
Appearance was determined by visible method according to the shape, size, length and width of the selected rice varieties which was categorized as short slender and medium slender.

Stickiness
Stickiness was determined by the visible method by the panel of teachers and students after the cooking of rice which was determined as more stickiness, medium stickiness and less stickiness.

Softness
Softness was determined by the visible method by the panel of teachers and students after the cooking of rice which was classified as more softness, medium softness and less softness.

Aroma
Aroma was determined by the method as given by Grain Quality Laboratory, IRRI. Powered 30-40 harvested milled rice grains were placed in a plastic box and added 5 ml of 1.7% KOH and covered. After one hour, the aroma was determined by the smell. *ldris and Motin* (1990) [8].

Overall acceptability
Overall acceptability was determined by the visible method by the panel of teachers and students after the cooking of rice which was classified as good, better and best overall acceptability

Statistical analysis
All sample extracts were prepared and analysis done using a complete randomized design at 5% level of critical difference. Analysis of variance (ANOVA) for the design was carried out to determine the significance of differences among different treatments.

Result and discussion
Water Uptake: The Data of Water Uptake were subjected to pooled analysis and the Result are presented according to different varieties of Salt Tolerant rice varieties are given in Table-1
Highest water uptake reported in variety NDR-97 (426.5ml) fallowed by CSAR-1604 (420ml) and CSAR-1620 (410.5ml) while lowest water uptake reported in variety CSR-30 (370ml). Similar result has been reported by Verma and Srivastava (1993) [20], Sarkar *et al.* (1994) [15].

Volume Expansion: The Data obtained on Volume Expansion during both years in respect to different varieties are given in Table-1
Highest Volume Expansion reported in variety CSAR-1610 (12.85mm) fallowed by CSAR-1620 (12.88mm) and Basmati-370 (10.04mm) while lowest water uptake reported in variety CSAR-1572 (12.85mm).As per report by Govindaswami *et al.* (1969) [5] and Ghosh and Chaudhary (1978) [4].

Table 1: Water uptake ml volume expansion mm

Varieties	Water Uptake (ml)			Volume Expansion (mm)		
	2018-2019	2019-2020	Pooled Mean	2018-2019	2019-2020	Pooled Mean
CSR-10	402	406	404	11.25	11.22	11.24
CSR-13	384	387	385.5	9.25	9.27	9.26
CSR-23	398	401	399.5	8.87	8.91	8.99
CSR-27	374	371	372.5	10.81	10.79	10.80
CSR-30	371	369	370	8.55	8.51	8.53
NDR-97	425	428	426.5	12.15	12.17	12.16
CSAR-1604	421	425	420	12.30	12.34	12.32
CSAR-1610	410	413	411.5	13.05	13.08	13.07
CSAR-1620	412	409	410.5	12.90	12.87	12.88
CSAR-1572	405	401	403	12.87	12.83	12.85
Mean	400	401	400	11.20	11.19	11.20
S.E.	2.8397	3.0979	2.102	0.3415	0.3151	0.232
CD(5%)	5.9259	6.4646	4.249	0.7126	0.6573	0.470

Kernel Elongation: Data obtained during the both years and pooled on Kernel Elongation are shown in Table-2. Highest Kernel Elongation reported in variety CSR-30 (12.36mm) fallowed by CSR-23 (12.33mm) and CSR-13(12.31mm) while lowest Kernel Elongation reported in variety CSAR-1572(11.34mm).this report has been supported by Bhonsle and Krishnan (2010) [2], Govindaswami *et al.* (1969) [5]

Kernel Elongation Ratio: The Data Pertaining to Kernel Elongation Ratio showing mean values of two years as well as pooled data are presented in Table-2. Highest Kernel Elongation ratio reported in variety CSR-30 (1.86mm) fallowed by CSR-23 (1.82mm) and CSR-27(1.78mm) while lowest Kernel Elongation Ratio reported in variety CSAR-1610 (1.53mm). Similar results of variety variations have been reported by Ghosh and Chaudhary (1978) [4] and Thayumanavan (1987) [19].

Alkali Spreading Value: Data obtained on Alkali Spreading Value during the both year and pooled date are shown in Table-2. Highest Alkali Spreading Value reported in variety CSR-30 (6.1) fallowed by CSR-27(5.9) and CSR-23(5.1)

while lowest Alkali Spreading Value reported in variety CSAR-1620 (2.8). Similar results of variety variations have been reported by Abidi *et al*. (1973) [1], Yi and Chen (1992) [21].

Table 2: Kernel elongation (mm) kernel elongation ratio (mm) alkali spreading value

Varieties	Kernel Elongation (mm)			Kernel Elongation Ratio (mm)			Alkali Spreading Value		
	2018-2019	2019-2020	Pooled Mean	2018-2019	2019-2020	Pooled Mean	2018-2019	2019-2020	Pooled Mean
CSR-10	10.85	10.82	10.83	1.70	1.72	1.71	5	4.8	4.9
CSR-13	12.30	12.33	12.31	1.76	1.74	1.75	4	4.3	4.1
CSR-23	12.32	12.35	12.33	1.80	1.83	1.82	5	5.2	5.1
CSR-27	11.15	11.13	11.14	1.77	1.79	1.78	6	5.8	5.9
CSR-30	12.35	12.37	12.36	1.84	1.89	1.86	6	6.2	6.1
NDR-97	10.13	10.15	10.14	1.71	1.73	1.72	4	3.8	3.9
CSAR-1604	10.09	10.07	10.08	1.69	1.71	1.70	4	4.5	4.3
CSAR-1610	11.09	11.11	11.10	1.55	1.52	1.53	3	3.2	3.1
CSAR-1620	10.12	10.09	10.10	1.59	163	1.61	3	2.7	2.8
CSAR-1572	11.36	11.32	11.34	1.70	1.68	1.69	4	3.6	3.8
Mean	11.18	11.17	11.18	1.71	1.71	1.72	4.4	4.5	4.5
S.E.	0.2323	0.2113	0.157	0.0258	0.0316	0.020	0.1291	0.1033	0.083
CD(5%)	0.4835	0.4417	0.317	0.0539	0.0647	0.041	0.2694	0.2155	0.167

Cooking quality

Cooking quality of Salt Tolerant varieties are shown in Table-3. In Appearance almost all salt tolerant rice varieties are long slender grain while some varieties have medium slender grain. CSAR-1572, CSAR-1604, and CSAR-1610 varieties have Medium stickiness, and less softness. CSR-30, CSR-13 and CSR-27 varieties have moderate aroma, less stickiness, more softness and good appearance. In overall acceptability CSR-30 and CSR-27 Varieties are best in salt tolerant rice varities. Sunitha and Padmavati (2001) [18]. Sharma (2004) [16] and Khush *et al.* (1988).

Table 3: Appearance almost all salt tolerant rice varieties are long

Salt tolerant rice					
Varieties	Appearance	Stickiness	Softness	Aroma	Over all acceptability
CSR-10	SS	Medium	Medium	Moderate	Good
CSR-13	LS	Medium	Less	Slight	Good
CSR-23	LS	Less	Medium	Medium	Better
CSR-27	LS	Medium	More	Moderate	Best
CSR-30	LS	Less	More	Moderate	Best
NDR-97	MS	More	Less	Slight	Good
CSAR-1604	LS	Medium	Less	Moderate	Good
CSAR-1610	LS	More	Medium	Slight	Better
CSAR-1620	LS	More	Medium	Slight	Good
CSAR-1572	LS	Medium	Less	Slight	Good
C.D.	N/A	N/A	N/A	N/A	N/A

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