Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

Research Article

Study of physicochemical, cooking and nutritional properties of promising rice varieties of Tamil Nadu

R. Pushpa, D. Sassikumar, K. Iyyanar, R. Suresh and R. Manimaran
Tamil Nadu Rice Research Institute, Aduthurai
E-Mail: pushpa.saravanan@gmail.com

(Received: 08 Mar 2019; Revised: 12 Jul 2019; Accepted: 18 Jul 2019)

Abstract
The present study was aimed to compare physiochemical and cooking properties of high yielding rice varieties of Tamil Nadu. Various physiochemical properties were studied in twenty five rice varieties. The milling percentage ranged between ADT 44 (50.0) to ADT 42 (71.0). HRR% varied from IR 50 (45.0) to CR1009 (64.0). The hulling percentage highly significantly associated with milling percentage, head rice recovery and gel consistency. Milling percentage positive significant association with HRR, BER and GC. The kernel length is highest in ADT 41(7.5 mm) which shows long grain length and lowest in short grain type ADT 37(4.9 mm) while the kernel breadth ranged between 1.9 – 2.9 mm. The Kernel length after cooking ranged from ADT 37(8.0mm) to ADT 41 (11.5mm). The volume expansion ratio in rice cultivars ranged from 3.27 in TKM 13 to 4.7 in ADT 39 and the gel consistency ranged from 48.0- 118.0 mm. The varieties IR50, ADT 45, ADT 41 and ADT 48 poses high zinc content more than 30µg/g in brown rice. The relationship between physical, cooking and nutritional properties was determined using Pearson’s correlation. Correlation was done for determining the nature of interaction among the characters. The cluster analysis suggested that the genotypes present in cluster I showed high hulling percentage, Milling percentage and Head rice recovery.

Key Word
Physical, cooking and chemical characters, Correlation

Introduction

Rice (*Oryza sativa* L.) is the most important food crop in the world, as it is a staple food for more than half of the world’s population. Rice eating quality largely determines its market price and consumer acceptance, because consumers pay particular attention to high eating quality. Quality of rice is not always easy to define as it depends on the consumer and the intended end use for the grain. All consumers want the best quality that they can afford. As countries reach self-sufficiency in rice production, the demand by the consumer for better quality rice has increased. Grain quality is not just dependent on the variety of rice, but quality also depends on the crop production environment, harvesting, processing and milling systems. Rice grain quality is determined by its physical and physicochemical properties. Physical properties include kernel size, shape, milling recovery, degree of milling and grain appearance (Cruz and Khush, 2000). Physicochemical properties of rice are determined based on amylose content, gel consistency and gelatinization temperature. In rice, eating and cooking qualities are mainly controlled by the physicochemical properties which greatly influence the consumer’s affinity (Rohilla, 2000). Volume expansion over cooking is another quality parameter which influences the edible volume which is the final output after cooking (Rebeira, 2014). Therefore, eating and cooking quality can be considered as a vital intrinsic quality component of rice grains that have to be focused in future rice breeding programmes to meet market demands.

Materials and Method

The investigation was carried out in Tamil Nadu Rice Research Institute during 2016 to evaluate physicochemical and cooking characters of twenty five high yielding popular rice varieties cultivated in Tamil Nadu to find out the better quality characters. Twenty five days old seedlings were transplanted in Randomized Block Design with three replications .After three months of harvest, samples were cleaned thoroughly using winnower to remove the chaff and other foreign matters and dried in hot air oven up to 12-14% moisture content and evaluation for physicochemical and cooking properties. Therefore, this study was conducted to evaluate the diversity of rice grain quality of promising high yielding rice varieties based on Milling, physicochemical, Cooking, and nutritional properties that will provide highly important information for future rice breeding programmes as well as for consumers.

The rough rice (Paddy) was cleaned, dried to 12-14% moisture content and dehulled with a Laboratory Sheller. After cleaning and weighing the dehusked kernel (brown rice) hulling % was

Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

calculate. Dehusked kernels were polished to remove bran and milling percent was calculated. Head rice or milling recovery is the estimates of head rice with more than 2/3 rd size and expressed as percentage.

$$\text{Head rice recovery} = \frac{\text{Weight of head rice}}{\text{Weight of rough rice}} \times 100$$

Kernel length, kernel breadth and length breadth ratio were measured using graph sheet and the mean was expressed in millimeters (mm).Based on average length, kernels were classified based on Standard Evaluation System (IRRI, 1996).

Milled head rice was cooked for the minimum cooking time as described by (Singh *et al.*, 2005).Ten unbroken milled kernels were measured for their length and breadth before cooking. The kernels were kept in porous cloth bags, tied and pre soaked in water for 20 minutes. The cooked rice was taken out from the bags and placed on a blotting paper to drain the excess water. Length and breath of ten cooked rice grains was measured in three replication and expressed in millimeters. The ratio of mean length of cooked rice to mean length of milled rice was computed as linear elongation ratio (Juliano and Perez., 1984). Breadth wise expansion **(BWER)** ratio was computed as the ratio of mean breadth of cooked rice to mean breadth of milled rice. Cooked length–breadth (L/B) ratio was determined by divided the cumulative length of five cooked kernels by the breadth of five cooked kernels. A mean of three replications was reported (Singh *et al.*, 2005).

Gelatinization Temperature was estimated based on Alkali Spreading Value (ASV) of milled rice. Standard Evaluation System (IRRI, 1996) was used to score ASV. Duplicate sets of six whole milled kernel of each entry were placed in Petri dish containing 10 ml of 1.7% potassium hydroxide (KOH) solution. The kernels were arranged in such a way to provide space between kernels for spreading. The plates were covered and incubated at room temperature for 23 hours. The appearance and disintegration of kernels was rated visually based on point numerical spreading scale.

Gel consistency was analyzed based on the method described by (Cagampang *et al.*,1973). Milled rice flour (50 mg) was weighed in duplicate into the test tubes. To this 0.2 ml of 95% ethanol containing 0.025% thymol blue and 2 ml of 0.2 N KOH were added. Contents were mixed using a vertex genie mixer. The test tubes were covered with glass marbles in order to prevent steam loss and to reflux the samples. The samples were cooked in a vigorously boiling water bath for 8 minutes to make the contents to reach 2/3 rd of the height of the tube. The test tubes were removed from the water bath and kept at room temperature for 5 minutes. The tubes were kept in an ice water bath for 20 minutes and laid horizontally on a table, lined with millimeter graph paper. The total length of the gel was measured in millimeter from the bottom of the tube after one hour. The test classified the rice into three categories as follows, Very flaky rice grains with hard gel consistency (length of gel,40mm or less);(b) Flaky rice grains with medium gel consistency (length of gel, 41 to 60);(c) Soft rice grains with soft gel consistency (length of gel more than 61mm).

The seeds harvested from these lines were dehusked using lab dehusker. zinc concentrations in brown rice samples were estimated by Energy dispersive X-Ray Fluorescence Spectrometry(XRF) method. This instrument is quite useful in non-destructive determination of relative iron and zinc concentrations

Result and Discussion

The hulling percentage varied from PMK 3 (55.0) to ADT 42(87.0). If the hulling percentage is high, then the recovery of rice also increases. Milling out turn is the measure of rough rice recovery during milling. It is one of the important properties to the millers. The rice millers prefer varieties with high milling and head rice recovery, where as consumers preference depends on cooking and eating qualities (Merca and Juliano, 1981). The milling percentage ranged between ADT 44(50.0) to ADT 42(71.0). Head rice recovery is the proportion of whole grains in milled rice. It varies depending on the variety, grain type, cultural practices and drying condition (Asish *et al*., 2006). HRR% is a heritable trait although environmental factors and post harvest handling are known to break the grain during milling. HRR% varied from IR 50 (45.0) to CR1009 (64.0). The hulling percentage highly significantly associated with Milling percentage, head rice recovery and gel consistency. Milling percentage positive significant association with HRR, BER and GC (Table.3).

The kernel length is highest in ADT 41(7.5 mm) which shows long grain length and lowest in short grain type ADT 37(4.9 mm) while the kernel breadth ranged between 1.9 – 2.9 mm. Depending on L/B ratio, 11 varieties *viz*; ADT36, AD 41, ADT 43, ADT 45, ADT 46, ADT 48,IR 50, IR 66,TRY 2, BPT 5204 having slender grain type. Only the varieties ADT 37 is a short bold type. Other varieties are having medium grain type. The value for each character for each varieties are given in Table-1.Consumer affinity to size and shape is highly variable. Grain shape, size and appearance are very important characters and determine the consumer's acceptability.

The Kernel length after cooking ranged from ADT 37(8.0mm) to ADT 41 (11.5mm). Elongation ratio is an important parameter for cooked rice. If rice elongates length wise, it gives finer appearance and it expands girth wise, it gives coarse look. Out 25 varieties tested the elongation ratio is highest in Improved white ponni (1.96). High expansion breadth wise is not a desirable quality attributes in high quality rice required to command premium in the market. The extent of water absorbed during cooking is considered an economic quality as it gives some estimate of the volume increase during cooking. Water uptake shows a positive significant influence on grain elongation. In the present study the volume expansion ratio in rice cultivars ranged from 3.27 in TKM 13 to 4.7 in ADT 39. It is the positive character for lower income group for whom quantity is important criteria. However, more will be volume expansion ratio; less will be energy content per unit volume. The correlation coefficient among the rice grain are presented in Table No.3 Kernel length showed positive and significant association with Kernel length after cooking and L/B ratio. Kernel breath showed positive highly significant association with Kernel breath after cooking while negatively significant with L/B ratio and breath wise elongation ratio. Kernel length after cooking showed positive significant associated with LER. These findings were in agreement with those of Danbaba *et al*. 2011, Mathure *et al* 2011 and Singh *et al* 2012)

Alkali digestion is one of the important indicators of the eating, cooking and processing quality of rice starch (Nishi.A *et al.*., 2001). In this study, determination of the alkali digestion classified the rice genotypes into three groups namely; low, intermediate and high alkali digestion. Similar classifications have been reported in Thai rice cultivars (Prathepha *et al*.,2005).The alkali digestion value and gelatinization temperature for all the variety were examined and presented in Table 2. The intermediate alkali digestion genotypes are the most preferred worldwide and given their good cooking qualities such as water absorption, moistness, volume expansion and softness upon cooling.

Gel consistency test was developed as an indirect method used in screening cooked rice for its hardness. The gel consistency was measured into soft, medium and hard and it was ranged from 48.0- 118.0 mm. Amylose content is considered to be the single most important characteristic for predicting rice cooking qualities. It is the major factor for eating quality (Juliano, 1993). It determines the hardness or stickiness of cooked rice, cohesiveness, tenderness, colour of cooked rice. Higher amylose content (>25.0%) gives non sticky soft or hard cooked rice. Rice varieties having 20-25% amylose content gives soft and flaky cooked rice. It is an indicator of volume expansion and water absorption during cooking. Intermediate amylose content (20-25%) is usually preferred by Indians. In this study, all the tested genotypes are having intermediate amylose content.

Zinc is an important micronutrient which has critical role in tissue growth, wound healing, connective tissue growth & maintenance, immune system function, prostaglandin production, bone mineralization, proper thyroid function, blood clotting, cognitive functions, fetal growth & sperm production. It is required for metabolic activity of enzymes (as a cofactor) involved in repair brain function & replacement of body cells. It's essential for cell division & synthesis of DNA & proteins. (Roy and Sharma, 2014) has screened 84 landraces for iron and zinc content. Iron content varied between 0.25 μg/g to 34.8 μg/g and Zinc content from 0.85 μg/g to 195.3 μg/g. Nepali Kalam had the highest Zinc content 195.3 μg/g followed by Govindobhog 138.6 μg/g, Begunbeej 20.4 μg/g and Ghiosh16.15 μg/g. In our study the varieties IR50,ADT 45, ADT 41 and ADT 48 poses high zing content more than 30μg/g.

Cluster analysis was performed and a dendogram was constructed which evinced the nature of phyogenetic classification among the population. The dendrogram constructed using of 25 genotypes and 14 characters were grouped in to two clusters (Table 4 , Fig.1). The cluster analysis suggested that the genotypes present in cluster I showed high hulling percentage, Milling percentage and Head rice recovery. Thus the cluster analysis provides some potential parents which can be utilized in future breeding programme for enhancement of cooking quality along with better yield.

Rice grain quality traits encompass the totality of all characteristics and features of rice or the rice products that meets the consumer demands and preference. Development of high yielding varieties accompanied with superior cooking quality is a vital requirement of rice breeding. Breeding for high yield has been quite successful over the years but improvement of the quality parameter along with yield has been lagging due to lack of potential genotypes which can be utilized as parents in hybridization programs.

Reference

Asish, K., Binod, R., Kalaiyarasi K., Thiyagarajan, and Manonmani, S. 2006. Physio-chemical and cooking quality characteristics of promising varieties and hybrids in rice (*Oryza sativa* L.). *Ind. Journal Genet,* **66**(2),107-112.

Cagampang, G.B., C.M. Perez and B.O. Juliano, 1973. A gel consistency test for eating quality of rice. *J. Sci. Food Agric* **24**: 1589–1594.

Cruz, N.D., and Khush, G.S. 2000. Rice grain quality evaluation procedures. In: R.K Singh, U.S. Singh and G.S.Khush (Eds). Aromatic rices. Oxford and IBH Publishing Co Pvt. Ltd, New Delhi, pp. 15-28.

Danbaba, N., Anounye, J.C., Gana, A.S., Abo,M.E. and Ukwungwu, M.N. 2011. Grain quality characteristics of *Ofada* rice (*Oryza sativa* L.): Cooking and eating quality. *International Food Research Journal* **18**: 629-634.

Rohilla, R., Singh, V.P., Singh U.S., Singh R.K. and Khush G.S. (2000). Crop husbandryand environmental factors affecting aroma and other quality traits. pp 201-216. In: Sing, R.K., Sing, U.S. and Khush, G.S. (Ed.). Aromatic rices. Oxford and IBH Publishing Co. Pvt.Ltd. New Delli, India.

Rebeira SP, Wickramasinghe HAM and Samarasinghe WLG. 2014. Diversity of Grain Quality Characteristics of Traditional Rice (Oryza sativaL.) Varieties in Sri Lanka. Tropical Agricultural Research **25**(4): 470 – 478 .

IRRI, (1996) Standard evaluation system for rice. IRRI, Los Banos, Phlippines

Juliano, B. O., Perez, C. M, and Perez, F. C. (1993). Screening For stable high head rice yields in rough rice. Cereal Chem **70**(6): 650-655.

Merca, F. E., and Juliano, B. O., (1981). Physico-chemical properties of starch of intermediate amylase and starch. *Satarke,* **33:** 253-260.

Mathure, S., Shaikh, A., Renuka, N., Wakte, K.,Jawali, N., Thengane, R. and Nadaf, A. 2011. Characterization of aromatic rice (*Oryza sativa* L.) germplasm and correlation between their agronomic traits. *Euphytica* **179**: 237-246.

Nishi, A., Nakamura, Y., Tanaka, N., and Satoh, H. 2001. Biochemical and genetic analysis of the effects of amylose-extender mutation in rice endosperm. *Plant Physiology* **127**: 459-472.

Prathepha, P., Daipolmak, V., Samappito, S., and Baimai, V. 2005. An assessment of alkali degradation waxy protein and their relation to amylose content in Thai rice cultivars. *Science Asia* **31**: 69-75.

Roy, SC., and Sharma, B. 2014. Assessment of genetic diversity in rice [Oryza sativa L.] germplasm based on agro-morphology traits and zinc-iron content for crop improvement. *Physiology and Molecular Biology of Plants*. **20**(2):209–24.

Singh, N., Kaur, L., Singh Sodhi, N., and Singh Sekhon, K. 2005. Physicochemical, cooking and textural properties of milled rice from different Indian rice cultivars. *Food Chemistry,* **89**: 253–259.

Singh, A.K., Singh, P.K., Nandan, R. and Rao, M. 2012. Grain quality and cooking properties of rice germplasm. *Ann.Pl. Soil Res.* **14**(1):52-57.

Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

Table 1. Physical, chemical, cooking and nutritional characters promising rice varieties

Varieties	KL (mm)	KB (mm)	Hulling (%)	Milling (%)	HRR (%)	L/B	KLAC (mm)	KBAC (mm)	LER	BWER	VER	ASV	GC (mm)	Zn (µg)
ADT36	5.8	1.9	74.0	64.0	58.0	3.1	11.4	2.6	1.96	1.36	4	2	70	26.63
ADT37	4.9	2.7	77.5	60.0	55.0	1.8	8.0	2.9	1.63	1.07	4.2	3	73	25.56
ADT38	4.9	2.4	72.5	55.0	50.0	2.8	7.1	2.8	1.02	1.16	4.5	3	60	20.70
ADT39	5.9	2.4	77.5	55.0	49.0	2.4	8.1	2.7	1.37	1.12	4.7	4	86	22.44
ADT40	6.1	2.5	70.0	55.0	50.0	2.4	9.9	2.9	1.62	1.16	4	3	62	24.29
ADT41	7.5	2.2	72.5	57.5	52.0	3.4	11.5	3.2	1.53	1.1	4.1	4	69	31.00
ADT42	6.3	2.3	87.0	71.0	63.0	2.7	10.3	3.2	1.63	1.39	4	3	118	28.62
ADT43	6.3	2.0	77.5	65.0	59.0	3.2	8.2	2.7	1.30	1.35	4	3	55	28.61
ADT44	5.7	2.6	77.5	50.0	46.0	2.1	10	3	1.75	1.15	4.6	3	75	21.09
ADT45	5.7	1.9	75.0	62.5	60.0	3	8.6	2.8	1.5	1.42	4.5	2	84	31.55
ADT46	6.7	2	67.5	67.5	57.0	3.3	9.5	2.3	1.41	1.15	3.9	2	74	19.96
ADT47	5.4	1.9	75.0	57.5	52.0	2.8	9	2.5	1.66	1.31	3.9	2	109	29.01
ADT48	6.7	1.9	82.5	65.0	58.0	3.5	9.2	2.4	1.37	1.26	4	2	118	30.10
ADT49	5.6	2.0	80.0	65.0	59.0	2.8	7.6	2.6	1.35	1.3	4.3	2	84	24.37
ADT50	5.6	1.9	75.0	65.0	60.0	2.9	8.2	2.7	1.46	1.42	4	2	94	21.57
I.W.Ponni	5.6	2	70.0	57.5	52.0	2.8	11	2.8	1.96	1.4	3.9	2	69	19.92
CR1009	5.5	2.5	80.0	70.0	64.0	2.2	8.9	3.3	1.61	1.32	4.3	5	59	20.41
TKM13	5.4	2	65.0	57.5	56.0	2.7	7.5	2.9	1.38	1.45	3.2	3	73	20.98
CO47	5.8	2.7	65.0	52.5	53.9	2.1	10.5	3.5	1.81	1.29	4.4	3	61	27.30
TPS-5	6	2.5	77.5	67.5	64.0	2.4	8.5	3.4	1.41	1.36	3.9	3	80	24.86
IR-50	6.3	2	60.0	52.5	45.0	3.2	8.9	2.5	1.41	1.25	4.2	2	62	34.21
IR-66	6.5	2	65.0	52.5	46.0	3.2	9.2	2.4	1.41	1.2	4	4	75	26.42
TRY-2	7.1	2.2	77.5	67.5	49.0	3.2	10.8	3.0	1.52	1.36	4	3	101	23.25
PMK-3	6.4	2.2	55.0	52.5	47.0	2.9	9.0	2.5	1.4	1.13	3.6	4	48	25.39
BPT5204	6.0	1.9	77.5	67.4	61.0	3.1	8.2	2.6	1.36	1.36	4.1	3	70	26.78
Mean	6.0	2.21	73.34	60.50	54.0	2.78	9.16	2.81	1.51	1.27	4.09	2.88	7.82	25.40
CV	10.98	14.08	9.92	10.59	13.73	16.58	13.53	11.54	14.37	9.09	7.76	28.91	29.16	15.79
SD	0.66	0.31	7.27	6.41	7.29	0.46	1.24	0.32	0.22	0.12	0.32	0.83	2.28	4.01
SE	0.13	0.06	1.45	1.28	1.46	0.09	0.25	0.06	0.04	0.02	0.06	0.17	0.46	0.80

KL:Kernal Length,KB:Kernel breath, HRR:Head Rice Recovery(%), L/B:Length breath ratio, KLAC: Kernel length after cooking (mm),KBAC: Kernel breadth after cooking (mm),LER:Linear elongation ratio, BWER:Breadth wise elongation ratio,VER: Volume expansion ratio, ASV:Alkali spreading Value, GC:Gel consistency (mm)

Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

Table 2. Alkali digestion value and gelatinization temperature for milled kernel of rice varieties

Alkali digestion value			Gelatinization Value		Varieties
Feature	**Interferance**	**Scale**	**Interferance**	**GT**	
1. Not affected but chalky	Low	1	High	75-79	-
2.Kernel swollen	Low	2	High	75-79	ADT36,ADT45, ADT46, ADT47, ADT48, ADT49 ADT50 IWPONNI ,IR-50
3. Kernel swollen with collar incomplete and narrow	Low to intermediate	3	High to intermediate	70-74	ADT37, ADT38, ADT40 ADT42, ADT43, ADT44 TRY-2,TKM13, CO47 TPS-5, BPT5204
4. Kernel swollen with collar complete and wide	Intermediate	4	Intermediate	70-74	ADT39,ADT41, IR-66 ,PMK-3
5. Kernel split or segmented with collar complete and wide	Intermediate	5	Intermediate	70-74	CR1009
6. Kernel dispersed, merging with collar	High	6	Low	65-69	-
7.Kernel completely dispersed	High	7	Low	65-69	-

Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

Table 3. Pearson Correlation coefficients between various physic-chemical and cooking properties of high yielding rice varieties

	KL	KB	H (%)	M (%)	HRR(%)	L/B ratio	KLAC	KBAC	LE ratio	BER	VE ratio	ASV	GC	Zn
KL	1	-0.003	-0.121	0.166	0.0856	0.514**	0.507**	-0.135	-0.134	-0.177	-0.208	0.101	0.068	0.290
KB		1	0.060	-0.266	-0.376	-0.790**	0.231	0.734**	0.169	-0.559**	0.351	0.584**	-0.360	-0.11
H (%)			1	0.652**	0.487*	-0.144	-0.045	0.253	0.050	0.239	0.349	-0.062	0.497*	-0.023
M (%)				1	0.820**	0.287	-0.039	0.101	-0.096	0.508**	-0.152	-0.137	0.453*	-0.047
HRR(%)					1	0.279	-0.079	0.085	-0.059	0.654**	-0.294	-0.151	0.343	0.01
L/B ratio						1	0.002	-0.716**	-0.385	0.260	-0.326	-0.441*	0.248	0.207
KLAC							1	0.254	0.723**	-0.023	-0.045	-0.013	-0.02	0.1507
KBAC								1	0.328	0.146	0.179	0.405*	-0.12	-0.097
LE ratio									1	0.175	0.010	-0.119	-0.01	0.008
BER										1	-0.326	-0.371	0.389	0.032
VE ratio											1	0.091	-0.1	0.060
ASV												1	-0.39	-0.188
GC													1	0.098
Zn														1

Kernel breath, Hulling (%),Milling (%), Head Rice Recovery(%), Length breath ratio, Kernel length after cooking (mm), Kernel breadth after cooking (mm), Linear elongation ratio, Breadth wise elongation ratio, Volume expansion ratio, Alkali spreading Value, Gel consistency (mm)
*P<0.05, **P<0.01

Table 4. Distribution of rice varieties in clusters

Cluster	Name of the Genotype
1	ADT36 , ADT 37, ADT42, ADT43, ADT45, ADT46, ADT47, ADT48 ADT49, ADT50, I.W.Ponni,I ,CR1009, TKM13, TPS-5, TRY-2, BPT5204
2	ADT38, ADT39, ADT40, ADT41, ADT44, CO47, IR-50, IR-66, PMK3

Electronic Journal of Plant Breeding, 10 (3): 1071 - 1078(Sep 2019) DOI: 10.5958/0975-928X.2019.00137.6
ISSN 0975-928X

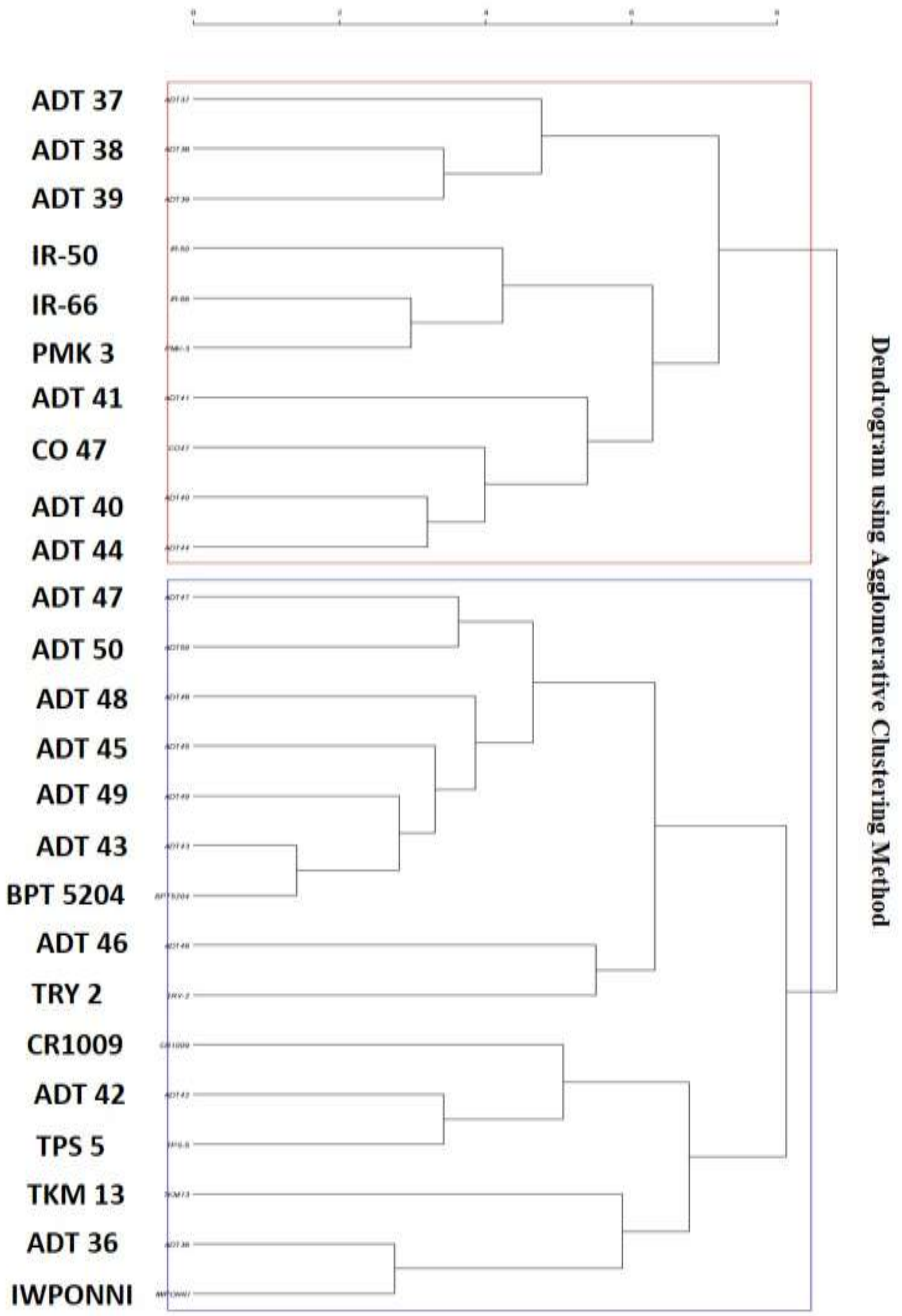

Fig.1. Dendrogram showing the distribution of 25 varieties in clusters.