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Quality characteristics of indigenous organic Indian rice variety: *Kouni nel*

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Abstract
Introduction
Kouni nel is one of the traditional rice varieties of South India which is unexplored commercially. The current study aimed to investigate the milling characteristics, physical characteristics, nutrient composition, physico chemical and cooking properties of the traditional organic rice variety Kouni nel.
Methodology
The organically grown traditional Kouni nel paddy was obtained from Centre for Indian Knowledge Systems, Chennai, India. The milling characteristics, physical characteristics, nutrient composition, physico chemical and cooking properties of Kouni nel were analysed using standard procedures.
Results
The study infers Kouni nel to be a long bold grain. On parboiling, Kouni nel exhibited better milling characteristics. The Kouni nel rice is non-aromatic variety with normal taste and acceptable cooking and textural characteristics. It is ideal to parboil and use it.

Keywords: Milling characteristics, Parboiling, Physico chemical properties, Kouni nel

1. Introduction
Rice (*Oryza sativa* L.) is a monocotyledonous plant belonging to the grass family (Gramineae) and the genus *Oryza*. Rice is the major staple food for the 57% of the world's population and it provides approximately 23% of daily caloric intake. Rice containing 20 wild species of generous *Oryza* with more than 100,000 varieties of cultivated forms is threatened by loss of bio diversity. Thousands of traditional variety had once existed, fewer than one hundred identified variations, were currently being cultivated by farmers in rural areas in Tamil Nadu based on their long cherished traits. The loss of these traditional varieties would not only cause insecurity in the rice growing areas of Tamil nadu, but also in other areas of India (Vijayalakshmi K *et al* 2007) [6]. Kouni nel is one such traditional variety which can be explored further for its yield, milling and cooking quality. The objective of this study was to analyse and evaluate the milling, physical, physicochemical, cooking and nutritive quality of organic traditional rice variety Kouni nel to optimize its usage and make it commercially viable.

2. Materials and Methods
2.1 Materials
The organically grown traditional Kouni nel paddy was obtained from Centre for Indian Knowledge Systems, Chennai, India.

2.2 Methods
2.2.1 Milling Characteristics
Milling
Kouni nel rice variety was first hulled using a commercial-scale Satake husker/paddy Separator (model APS-30CX) and then milled in a single pass using a commercial-scale sataked friction Mill (model BA-7). Head rice was separated from brokens using a satake test rice grader with a 5.2 mm long-grain screen. (Chen H and Siebenmorgen TJ 1997) [11].

Parboiling Method
Soaking was carried out simply by putting paddy (1-4kg) in hot water (90-95 ^{0}C) in a metal pail, covering with jute sacks and leaving overnight. This procedure enabled sufficiently rapid hydration without requiring any particular care. After the immature grains were skimmed off and the paddy was drained and washed, it was steamed for 10 min at atmospheric pressure. Parboiling thus was done, on the whole, under mild conditions, so that the drying conditions could be tested on a more susceptible grain. The paddy was taken on wire-mesh trays and stirred manually at intervals of 5 to 10 min and dried in a cabinet drier. Moisture was determined at intervals and samples were withdrawn at desired stages after through mixing. (Bhattacharya and Rao, 1966) [7].

Husk Percentage
Husk percentage was calculated using the equation

$$\text{Husk yield \%} = \frac{\text{Weight of husk collected}}{\text{Total weight of paddy}} \times 100$$

Broken Percentage
The percentage of the broken rice was calculated using the following equations (Alizadeh *et al* 2009) [4]

$$\text{\% Brokens} = \frac{\text{Weight of broken grains (less than ¾ size)}}{\text{Weight of paddy samples}} \times 100$$

Shelling Breakage Percentage:
From the broken rice percentage, the shelling performance was determined by calculating the ratio of the weight of shelled kernals to the total weight of the rice sample.

Head Rice Yield Calculation:
The head rice yield (HRY%) was calculated using the following equation

$$\text{\% Head rice} = \frac{\text{Weight of whole grains}}{\text{Weight of paddy samples}} \times 100$$

Polished Rice yield
Polished Rice yield was calculated using the equation

$$\text{Polished rice yield \%} = \frac{\text{Weight of polished rice}}{\text{Weight of brown rice}} \times 100$$

2.2.2 Physical Characteristics
Length, Width, and Thickness
The length, width, thickness and mass of paddy grains were measured in randomly selected 100 paddy grains. The length, width and thickness of grains were measured using vernier callipers to an accuracy of 0.01 mm

Length/Breadth Ratio
The length- breadth ratio was determined by dividing cumulative length of ten kernels by the cumulative breadth of ten kernels. The average of five replications was reported (Gujaral *et al* 2003) [13].

Thousand Grain Mass
The thousand grain mass was determined by means of a digital electronic balance having an accuracy of 0.00 g. To evaluate the thousand grain mass, 100 randomly selected grains from the bulk sample were averaged and then multiplied × 10 to give the mass of thousand grains (Zareiforoush *et al* 2009)[31].

Surface Area
Grain surface area (S) was calculated using the formula given by Jain and Bal (1997) [18].

$$S = \pi BL^2 / 2L-B$$

Where:

$$B = \sqrt{WT}$$

S = surface area, L = length, B = breadth, W=width, T = thickness

Angle of Repose
The angle of repose is the angle with the horizontal at which the material will stand when piled. This was determined by using the apparatus consisting of an adjustable plywood box of 140×160×35mm and an electrical motor to lifting the box. The adjustable box was filled with the sample, and then was inclined gradually by the electrical motor allowing the grains to follow and assume a natural slope; this was measured as emptying angle of repose (Zareiforoush *et al* 2009) [31].

Sun Checks
The number of fissured kernels was counted in 100 rice kernels which were randomly taken. The kernel was inspected using a grain scope (TX-200, Kett Electric Laboratory, Tokyo, Japan) and based on light reflection on the grain sun checks was determined (Hashemi *et al* 2008) [15].

Grain Hardness
Grain hardness was determined as force required to break a kernel using texture analyzer (TA.XT Plus, Stable Microsystems) at a crosshead speed of 5mm/s (Yadhav *et al* 2007) [30].

Bulk Density
Milled rice kernels were poured into a certain known volume from a fixed height and mass of samples occupying the volume was determined. Ratio was calculated g/l (Gujaral *et al* 2003) [13].

Colour of Grains
Whiteness of the parboiled rice sample was measured using a Kett digital whiteness meter (Model C-300, Japan). Before measurement, the meter was calibrated against standard white at a percent whiteness of 88.1 (Parnsakhorn and Noomhorm, 2008) [23].

Measuring Chalkiness (Visual Rating)
Rating the degree of chalkiness by sight is the most common procedure used in any breeding work or in grading for marketing value. The percentage of the chalky area of grain is determined visually and is rated on a scale of 0 to 9 according to increasing intensity as given in standard evaluation system (Kushibuchi, 1973) [20].

2.2.3 Nutrient Analysis
Moisture content, Protein, Total lipids, Starch, Amylose, Sand silica, Crude fibre was determined by (AOAC 1985) [5] method.

2.2.4 Physico Chemical and Cooking Quality
Equilibrium Moisture Content On Soaking:
For the test 2–4 g of rice was put in about 50ml of water in a 100ml beaker, covered with a Petri dish and put aside. The rice was drained after 20–24 hrs and thoroughly pressed with filter papers. Then its moisture content was determined by drying in an oven at 105 ºC for 24 hrs. (Brady, 1979) [9]

Water Uptake Ratio

For the test, 2.0g of whole grain rice was cooked in 20ml of distilled water in a test tube for 20min in a thermostatically controlled (60 ºC and 98 ºC)water bath. The increase in the weight of rice divided by the original weight gives the apparent water uptake (g water absorbed/g rice). The ratio of the values determined at the two temperatures was then calculated and expressed as percent. Since the index is a ratio, the apparent water uptake determined as above is sufficient, the true water uptake value being unnecessary (Ali and Bhattacharya, 1972) [3].

Gelatinization Temperature

Gelatinization temperature was determined by using the procedure of Little *et al* 1958[21]. Whole milled kernels were placed in small petri dishes containing 10 ml of 1.7% KOH. The petri dishes were covered and incubated for 23 hours at 30 ºC. The individual grains were then classified visually according to the following spreading scale based on the degree of alkali digestion of the rice kernel.

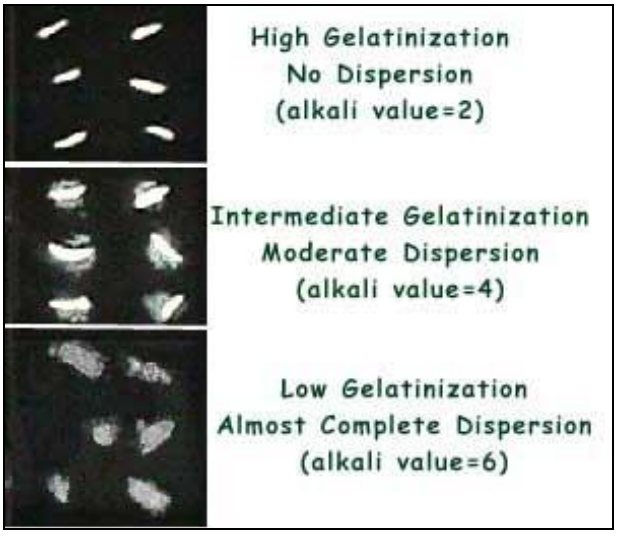
Table 1: Classification of Rice Based on Alkali Digestion Value

Score	Alkali Digestion	Gelatinization Temperature	Temperature Range (ºc)
1-2	Low	High	75 - 79
3	Low/intermediate	High/ Intermediate	75–79/70-74
4-5	Intermediate	Intermediate	70-74
6-7	High	Low	55-69

Table 2: Alkali Spreading Scale

Score	Spreading
1.	Kernel not affected
2.	Kernel swollen
3.	Kernel swollen, collar incomplete and narrow
4.	Kernel swollen, collar complete and wide
5.	Kernel split or segmented, collar complete and wide
6.	Kernel dispersed, merging with collar
7.	Kernel dispersed completely and intermingled

Fig 1: Gelatinization of Rice Kernel and Alkali Spreading Value



Gel Consistency

Textural properties and profiles of rice flour gels were evaluated using a texture analyzer (TA.XT2, Texture technologies, England). Rice flours were cooked in water (8% w/v in distilled deionized water) at about 99 ºC for 2 minutes; the hot paste was poured into 50ml beakers, covered and cooled to room temperature. Gels formed were stored for 24 hours at 4 ºC. Beakers containing gels were secured on a steel plate fitted with a rubber gasket at the centre to hold the sample container. A flat bottomed probe 3.5 cm long and 0.75 cm in diameter was used to measure hardness. (Hettiarachchy *et al*, 1997) [16]

Optimum Cooking Time

The head rice 2g was taken in a test tube from each sample cooked in 20ml distilled water at 90 ºC in a water bath. The minimum cooking time was determined by removing a few kernels are different time intervals during cooking and pressing between two glass plates until no white core was left. Water absorption of cooked rice was determined by the increase in weight of rice after cooking to optimum cooking time. (Singh *et al*, 2005) [25]

Elongation Ratio

According to Sood *et al* 1979 [27] cumulative length of cooked rice kernels was divided by length of 10 cooked raw kernels and the result was reported elongation ratio.

Gruel Solid Loss

Head rice samples (2g) in taken in a test tube containing 20ml distilled water. The rice was cooked for optimum time in a hot water bath. The gruel was transferred into a dry and pre weighed aluminium dish and kept at 100 ºC for 24hrs to remove moisture. The aluminium dish was cooled in desiccators and weighed to determine the increase in weight of the dish. The average of three replications was reported. (Gujral *et al*, 2003) [13]

Hardness and stickiness

Hardness is the force required to bite through the sample with the molars and stickiness is the degree to which the kernels adhere to each other. Hardness and stickiness were measured by using the texture analyzer (TA XT2, England) equipped with cylinder probe 35 mm. The texture analyzer settings are mode: measure force in compression, option: return to start, pre-test speed: 0.5 mm/s, test-speed: 0.5 mm/s, post-test speed: 10 mm/s and strain: 90%. (Theanjumpol *et al*, 2007) [29].

Sensory Evaluation

A panel consisting of fifteen members trained in descriptive analysis participated in the study. The sensory profile included 5 sensory attributes that described rice at different phase of sensory evaluation. Beginning with the feel of the rice when it was first placed in the mouth and ending with mouth feel characteristics after the rice was swallowed. Drinking water was used to cleanse the mouth between the samples (Champagne *et al* 1997) [10].

3. Results and Discussion

3.1 Milling Characteristics

Head Rice Yield and Broken Rice Kernels of Milled and Parboiled Kouni nel

Head rice yield (HRY) is the primary parameter used to quantify rice milling quality. HRY of raw Kouni nel rice was 23.53% and that of parboiled was 71.47%. Head rice yield of Kouni nel rice had increased up to 67.07% after parboiling.

According to Dipti *et al* (2002) [12] good quality rice will have an HRY of at least 70%. The raw milling quality of Kouni nel is not satisfactory but parboiling Kouni nel improves its milling quality.

Shelling Breakage of Milled and Parboiled Kouni nel

The shelling breakage for milled Kouni nel was 13% and this

could be attributed to the increased broken kernel percentage (64.10%) observed in raw milling. The shelling breakage of parboiled Kouni nel was 8.5%. On parboiling the shelling breakage had decreased by 34.6% and the broken kernels were very less (0.60%).

Islam *et al* (2004) [17] reported that milling yield improved and the levels of broken decreased as parboiling intensity was increased (higher soaking temperature and longer steaming time).

Husk %, Polish Rice Yield and Polish % of Milled and Parboiled Kouni nel

Rice kernel is covered by two layers. The most outer layer is called husk (hull) and the inner one called bran. The whole rice kernel before removing these layers called paddy (rough rice). Husk and bran are not eatable; therefore, they must be removed from paddy. Husk has not tightly stuck to the kernel, so it is easily removed from the kernel. When this layer is removed the kernel is called brown rice. Bran is more difficult to be removed from brown rice, because it has tightly attached to the kernel. The process over which the bran is removed from brown rice is called whitening or pearling process.

Kouni nel had 26.02% and 24.21% husk on raw milling and parboiling respectively. The polished rice yield on raw milling was 65.55% and on parboiling the polished rice yield increased by 9.6%. Raw Kouni nel was subjected to 7.3% polish and the parboiled sample to 4.4%. Parboiling Kouni nel had greater head rice and polished rice yield, less shelling breakage and brokens.

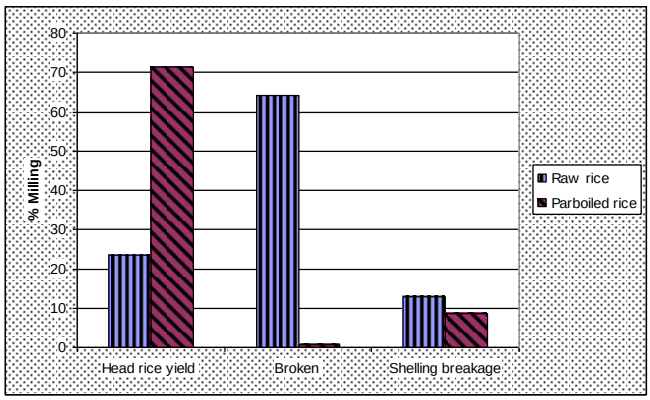


Fig 2: Head rice yield, broken rice kernels and shelling breakage of milled and parboiled Kouni nel

3.2 Physical Characteristics

Length, Breadth, and Thickness of Kouni nel Paddy and Brown rice, Length/Breadth ratio and categorization

The length and breadth of a rice grain are important attributes that determine the class of rice. Thickness of kernels has an important role on the magnitude of moisture gradient in kernels. Grain thickness has a major effect on the volume expansion ratio of the cooked rice followed by degree of milling and then by apparent amylose content of the grain (Mohapatra and Bal, 2007) [22]

The length and breadth of Kouni nel paddy and brown rice was found to be 8.4, 3.2 and 6.5, 2.5mm respectively. The thickness of Kouni nel rice paddy and brown rice was found to be 1.9 and1.5mm respectively. Length/Breadth ratio of Kouni nel paddy and brown rice was found to be 2.6mm respectively. Kouni nel was categorized as LONG BOLD RICE variety

1000 Grain Weight and Surface Area of Paddy and Brown Rice

Grain weight provides information about the size and density of the grain. Grains of different density mill differently and are likely to retain moisture differently and cook differently. Uniform grain quality is important for consistent grain quality. 1000-grain weight of rice is a physical property to determine the grain yield and quality.

1000 grain weight of Kouni nel paddy and brown rice was found to be 24.0 and 17.8 g respectively. Surface area of Paddy and Brown rice was found to be 2171.02 and 1774.49 mm^2/g respectively.

Angle of Repose

The data on the angle of repose will be useful in hopper design for gravity flow since the angle of inclination of the hopper walls should be greater than the angle of repose to ensure continuous flow of the material (Alizadeh *et al* 2006) [4]. Angle of repose of Kouni nel rice variety was 39.5˚.

Sun Checks

Sun cracks/Sun checks is the fine crosswise cracking of the grain, typically due to exposure to sun and rapid drying. Sun checks of Kouni nel rice were found to be 6.0% respectively. This might be the reason for the greater swelling breakage (13%) and broken kernels (64.1%).

Hardness and Bulk Density

Hardness is one of the most important physical properties as it reduces breakage during milling which further makes significant influence in increasing the market value and consumer's acceptability. The Hardness of Kouni nel rice was found to be 6.11kg. This might be responsible for increased broken kernels 64.10%.

The Bulk density of rice is dependent on grain type (long; medium, and short grain), moisture content, kernel density and additional physical properties such as kernel shape and dimensional characteristics Bulk density of Kouni nel rice was found to be 551g/l with the moisture content of 9.4%.

Singh *et al* 2005 [25] reported that larger grain rice showed lower bulk densities. Kouni nel showed lower bulk density being a long bold rice variety.

Colour of Brown and Milled Rice

Colour and cooking characteristics of the milled rice are the important factors deciding the quality that influence the price of the rice.

Whiteness is a combination of varietal physical characteristics, and the degree of milling. The whiteness of brown rice was 5.9 whereas in milled rice the whiteness was 25.5.The transparency of Brown rice was 0.14% and in milled rice it was 0.76%.

Chalkiness of Brown Rice

Table 3: Physical Characteristics of Kouni nel

Physical characteristics parameters	
1000 grain weight (Paddy) g	24
1000 grain weight (Brown rice) g	17.8
Surface area (Paddy) mm^2/g	2171.02
Surface area (Brown rice)mm^2/g	1774.49
Angle of repose (degree)	39.5˚
Sun checks (%)	6.0
Hardness (kg)	6.11
Bulk density (g/l)	551
Overall chalkiness score (%)	3.2
Chalky grains (%)	68
Whiteness(Brown rice) %	5.9
Whiteness(Milled rice)%	25.5
Transparency(Brown rice)	0.14
Transparency(Milled rice)	0.76

Chalk is the opaque area in the rice grain and is undesirable in almost every market. Kim (1998) [19] reported that the percentage of broken and chalky kernels is major grading factors. The chalkiness score of Kouni nel brown rice was 0,1,5,7 and 9 are 32, 26, 13, 14 and 14 respectively
Overall chalkiness score of Kouni nel was 3.2 respectively. Kouni nel have a greater percentage (68%) of chalky grains. This could be attributed to the greater percentage of brokens (64.1%) obtained.

3.3 Nutrient Composition of Raw Milled Kouni nel Rice

Table 4: Nutrient Composition of Kouni nel (raw milled)

Nutrients	
Paddy Moisture content%	9.4
Rice Moisture content%	8.53
Protein %	9.59
Starch %	79.2
Oil % in Rice	18.8
Oil % in Rice bran	0.50
Fiber % in Rice	0.2
Fiber % in Rice bran	5.5
Sand silica %	0.01

The optimum paddy moisture content for milling process is 12 to 14% wet basis (Afzalinia *et al* 2002) [1]. Paddy and Rice Moisture content of Kouni nel was found to be 9.4 and 8.53% respectively (Table: 2). This could be attributed to the greater percentage of brokens (64.1%) obtained.
Oil content of Kouni nel rice bran and rice was found to be 18.8 and 0.50% respectively. Fibre content of Kouni nel rice bran and rice was found to be 5.5 and 0.2% respectively. Rice is one of the crops with highest silicate content, mainly in the husk. Silica has long been recognized as a beneficial element for rice, although it has not been proved as an essential element. Sand silica content of Kouni nel rice was found to be 0.01%. Starch is the major constitute of the rice grain. Starch content of Kouni nel rice was 79.2%. Protein is the second most abundant component of rice. Commonly eaten rices generally contain about 7% protein and do not fluctuate widely from this level (Harris and Juliano, 1977) [14]. Kouni nel had 9. 59% protein content which was found to be greater than other varieties reviewed.

3.4 Physico Chemical and Cooking Characteristics Raw Kouni nel Rice

Equilibrated Moisture content and Water Uptake ratio

Table 5: Physico Chemical and Cooking Characteristics of Raw Milled Kouni nel Rice

Parameters	
Equilibrated moisture content (%)	36.99
Water uptake ratio(at 60 ºC)	0.17
Water uptake ratio(at 98 ºC)	0.96
Total Amylose%	23.5
Gruel loss %	10.5
Gelatinization temperature (ºC)	74.58
Gel consistency	50.5 (Medium)
Optimal cooking time (min)	24
Cooked rice volume (ml/10g)	380
Cooked rice Length mm	9.4
Cooked rice Breadth mm	3.1
Cooked L/B ratio	3.03
Elongation Ratio	1.65
Elongation Index	1.33
Aroma	Absent
Taste	Normal

The equilibrated moisture content of milled Kouni nel on soaking for 24 hours is 36.99% in dry basis. It's quite important to understand the water absorption characteristic of polished rice. The water uptake of Kouni nel at 60 ºC and 98 ºC were investigated and it was found to be 0.17 and 0.96 respectively.

Amylose content

Amylose content has been used as a basic parameter for classification of rice. Based on their amylose content (dry base), rice can be classified as follows (Juliano, 1979) [18a]

Table 6: Classification of rice based on the Amylose content

Waxy Rice	0 – 2.9%
Very low amylose rice	3 – 9.9%
Low amylose rice	10 – 19.9%
Medium amylose rice	20 – 24.9%
High amylose rice	>25%

Total amylose content was found to be 23.5%. Based on the amylose content Kouni nel rice can be classified as medium amylose rice.

Gruel Solid Loss

Gruel solid loss has a significant correlation with amylose content. Amylose is known to leach out during cooking and the higher amylose content is liable to leach more in to the cooking water. Kouni nel being medium amylose variety exhibited 10% solid gruel loss.
Rice varieties with low amylose content exhibit less solid gruel loss. IR8 with 6.8% amylose content had 3.76% gruel solid loss; PR-113 with 15.4% amylose content had 8.53% gruel loss (Singh *et al*, 2005) [25].

Gelatinization Temperature

Alkali spreading test are commonly used by rice researchers to obtain an estimate of cooking time of the milled grain by chemical means. Alkali spreading values in turn shows a strong inverse relation to gelatinization temperature which is frequently used as a mean for placing varieties into low, intermediate and high cooking temperature classes.
The mean alkali score of Kouni nel rice is 2.8 which indicate low alkali digestion and the corresponding gelatinization temperature of Kouni nel was found to be 74.58%. (based on table1)
Rice varieties classified as low gelatinization require less than 69 ºC, intermediate type from 70 to 74 ºC and high gelatinization require temperature above 74 ºC (Akhtar *et al*, 1996) [2].
So Kouni nel is inferred to possess high gelatinization temperature. The higher gelatinization temperature might be due to the higher amylose content (23.5%) of Kouni nel variety.

Gel consistency

Gel consistency measures the tendency of the cooked rice. The gel consistency in Kouni nel rice was found to be 50.5. The gel consistency of Kouni nel rice is categorized as medium gel. Harder gel consistency is associated with harder cooked rice and this feature is particularly evident in high amylose rice was found to possess medium gel consistency. Gels from long grain variety generally were harder than medium.
Kouni nel a long bold rice with length/breadth ratio of 2.6 with medium amylose content (23.5%) was found to possess medium gel consistency.

Table 7: Classification of Gel Consistency (Tang *et al* 1991) [28].

Classification	Length of Gel (mm)
Hard	27-35
Medium Hard	36-40
Medium	41-60
Soft	61-100

Cooking Time, Cooked Volume, Cooked L/B, Elongation index

The optimal cooking time of Kouni nel rice was found to be 24 min and the cooked rice volume was 380 ml/10g.Singh *et al* (2004) [26] reported that the cooking time showed a negative correlation with amylose content and a positive correlation with bulk density of milled rice. The medium amylose content (23.5%) and the bulk density (551g/l) of milled Kouni nel rice might be responsible for the longer cooking time. The Kouni nel rice was found satisfactory in terms of cooked rice volume. The cooked rice length and breadth of Kouni nel was found to be 9.4 and 3.1 mm respectively. The length and breadth ratio was 3.03 mm. The elongation ratio and elongation index of Kouni nel was found to be 1.65 and 1.33.

Hardness and Stickiness of Kouni nel rice variety

The texture of cooked rice grains is expressed in terms of their hardness or firmness and stickiness or adhesiveness, as well as moistness to touch (Ramesh *et al*, 1999) [24].

Table 8: depicts the hardness and stickiness of Kouni nel rice variety.

The hardness of Kouni nel rice was 2173.133 ± 209.921g. The stickiness of rice was -99.868 ± 36.316g.

The amylose content of rice has been reported to have a positive relationship with the sensory or instrumental values of hardness and an inverse relationship with the stickiness of cooked rice. (Bhattacharya *et al*, 1979) [8].

Singh *et al* (2005) [25]stated the hardness value of PR – 113, IET – 16313, Bas – Super, PR – 111 was found to be 91.0, 85.6, 79.6, 73.8N respectively, which has a corresponding amylose content values 15.4, 11.7, 10.22 and 12.8mg respectively.

The medium amylose content of Kouni nel rice variety (23.5%) might be responsible for the hardness and stickiness observed on textural analysis.

Table 8: Hardness and Stickiness of Kouni nel rice variety.

Parameters	Kouni nel
Hardness	Mean : 2173.133, SD : 209.921, CV : 9.660
Stickiness	Mean : -99.268, SD : 36.316, CV - -36.364

Sensory Evaluation

The results of sensory analysis revealed the absence of aroma in Kouni nel. The taste was found to be normal.

4. Conclusion

The quality characteristics of traditional organic Indian rice, investigated in this study indicate that Kouni nel is a long bold grain. It was observed that this rice variety had good milling and cooking characteristics. Parboiled Kouni nel had greater head rice and polished rice yield, less shelling breakage and brokens. Kouni nel rice can be classified as medium amylose rice and was found satisfactory in terms of cooked rice volume and elongation index. Kouni nel is inferred to possess high gelatinization temperature. The medium gel consistency indicates that the rice would maintain good grain integrity on cooking. It is non-aromatic variety with normal taste. Kouni nel had 9.59% protein content which was found to be greater than other varieties reviewed. The study recommends optimizing the usage of Kouni nel for its acceptable characteristics.

5. Recommendations

A comparative evaluation of parboiled and milled rice on its physico chemical, nutrient composition and cooking properties can be carried out.

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