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Physico-chemical and organoleptic quality characteristics of *Sampada* rice variety cooked with different ingredients

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Abstract
Newly released, high yielding rice variety *Sampada* (DRR Dhan 37) was assessed for physicochemical and organoleptic quality characteristics. The results of physical properties of rice showed that the variety has slender shape properties (L/B ratio- 2.33mm) and it is a low ASV (3.36) rice variety. Physicochemical and organoleptic quality characteristics were evaluated by cooking with selected ingredients such as salt, vinegar, and oil (sunflower oil, groundnut oil and rice bran oil). Alkaline spreading value (ASV) for rice cooked with different ingredients ranged from 2.99 to 3.90 and it was rated as low ASV variety with acidity ranging between 0.006 to 0.009, pH-5.85 to 8.34 and gelatinization temperature ranging 54°C to 74°C. The mean cooking time of rice cooked with adding different ingredients was 18 min. There was a significant difference observed in elongation ratio, L/B ratio after cooking, gruel loss and sensory properties among rice cooked by adding different ingredients.

Keywords: Sampada rice variety, physical properties, chemical properties, cooking quality, salt, oil.

Introduction
Rice is an important cereal grain which feeds nearly half of the world's population. Rice is usually consumed as a whole grain after milling and cooking, and in regular Asian diet, can contribute for 40-80% of total calorie intake. The improvement of grain quality is the major objectives being an integrated trait comprising grain size, shape, aroma, texture and appearance and cooking qualities (Eram *et al.,* 2014) [15]. Consumer's preference varies based on the type of rice and their origin (Azabagaoglum *et al*., 2009) [3].
Quality of rice may be considered from the viewpoint of size, shape, appearance of grain, and cooking properties (Cruz and Khush, 2000) [5]. Rice grain size and shape have a direct effect on the marketability and commercial success of improved rice cultivars. Long and slender grain cultivars are generally preferred by the consumers in South Asian, Middle East and Near East Asian countries (Hossain *et al.* 2009) [8]. The alkali degradation value and gelatinization temperature are major traits, which are directly related to cooking and organoleptic qualities. Grain quality evaluation always helps the consumers to select better rice varieties. Cooking quality of rice is one of the important factors influencing the acceptability of consumers.
Study conducted by James. (2015) [16] in a traditional non-fortified rice reported that cooking rice by adding coconut oil and refrigerating for 12 hours enhanced resistant starch (RS) by 10 times. However studies on physicochemical and organoleptic quality characteristics of rice cooked with different level of these ingredients (salt, vinegar and oils) are lacking. Therefore, the study was planned to investigate the effect of cooking rice by adding different types of oils (sunflower oil, groundnut oil and rice bran oil) salt and vinegar on physicochemical and organoleptic quality characteristics of newly released rice variety *Sampada*.

Material and Methods
Rice variety *Sampada* was procured from ICAR- Indian Institute of Rice Research, Rajendranagar, Hyderabad. Selected ingredients such as salt, refined oils (sunflower oil, groundnut oil and rice bran oil) and vinegar were procured from local markets. Physicochemical parameters such as 1000 kernel weight, L/B, volume (cm), bulk density (AOAC. 1990) [2] expansion ratio (Sahay and Singh 2005) [9], **a**cidity, pH (Ranganna 1986) [13], ASV, gelatinization temperature (Little *et al.,* 1958), cooking time, cooking weight and cooking loss (AACC, 1995) [1] were determined following standardized methods. Rice was prepared by the method given by Daomukda *et al*. (2011) [7] by adding salt, vinegar (1%, 2% and 3%) and oils (sunflower oil/ groundnut oil / rice bran oil at three different levels 2.5%,

5.0% and 7.5%). Sensory evaluation of cooked rice was done by a semi-trained panel from Post Graduate & Research Centre, PJTSAU using 9 point hedonic scale (Meilgaard *et al*., 1999) [18].

Results and Discussion

The physical parameters of *Sampada* rice variety were statistically analysed and presented in Table. 1. The L/B ratio decides the shape and category size of rice grain i.e. L/B ratio > 3.0 is for slender shape, 2.1 to 3.0 is for medium shape while ≤ 2.0 is called as bold grain (Cruz and Khush (2000) [5]. In *Sampada* rice variety mean 1000 kernel weight (g) was 15.37±0.09g, kernel length 5.47±0.12mm, breadth 2.13±0.11mm, L/B ratio 2.33±0.10mm, bulk density 2.44±0.02 g/ml and volume expansion was 19.60±0.58 ml.

Table 1: Physical properties of *Sampada* rice variety

S. No	Physical properties	Mean
1.	1000 kernel weight (g)	15.37±0.09
2.	Kernel length (mm)	5.47±0.12
3.	Kernel breadth (mm)	2.13±0.11
4.	L/B ratio (mm)	2.33±0.10
5.	Bulk density (g/ml)	2.44±0.02
6.	Volume expansion (ml)	19.60±0.58

Note: Values are expressed as mean ± standard deviation of three determinations.

These results were in conformity with the results of Thomas *et al*. (2013) [20] who evaluated six different rice varieties for physiochemical properties and cooking qualities and reported that the lowest 1000-kernel weight was found in white rice (16.97 g). Glutinous rice had highest 1000-kernel weight (19.43 g) followed by Bario rice (19.23 g) and brown rice (18.66 g). Overall, highest l/b ratio was found in the local white rice (3.75), whereas, the lowest ratio was observed for brown rice (2.09). Among the different varieties, bulk density was observed to be highest in brown rice (0.86 g/ml), followed by glutinous rice (0.83 g/ml) and Bario rice (0.82 g/ml).

Fan *et al*. (1998) [9] reported that bulk density of various rice cultivars varied from 0.82 to 0.85 g/ml, (higher for coarse grains). The BD was observed to be maximum for short grains and minimum for longer ones. In general, it was observed that bulk density was inversely related to l/b ratio. The medium grain cultivars i.e. brown rice and white rice had higher bulk density than the long grain cultivars.

Organoleptic quality characteristics of rice cooked by adding selected ingredients

The mean sensory evaluation scores for rice cooked by adding salt are presented in Figure.1. Colour, flavour, taste, texture and overall acceptability of rice cooked with salt and control ranged 1.00±0.00 to 8.40±0.22, 3.00±0.36 to 8.60±0.16, 2.40±0.16 to 8.30±0.15, 3.70±0.30 to 8.50±0.167 and 1.00±0.00 to 5.60±0.22 respectively. The highest rating of colour, flavour, taste, texture and overall acceptability was seen in rice cooked with salt at 2.5% followed by control and lowest rating was seen in rice cooked with salt at 7.5%. No significant difference was observed from control to experimental samples and also within the treatments.

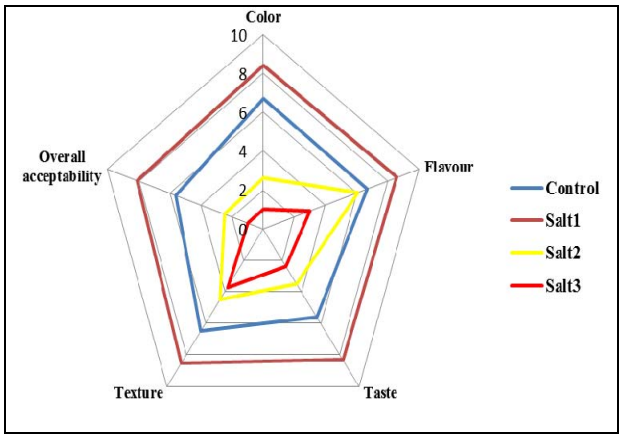

Fig 1: Sensory evaluation scores of rice cooked with salt

The mean sensory evaluation scores for rice cooked by adding vinegar is presented in Figure.2. Colour, flavour, taste, texture and overall acceptability of rice cooked with VIN and control ranged from 2.40±0.20 to 8.40±0.22, 2.60±0.16 to 7.80±0.20, 2.80±0.50 to 8.50±0.16, 4.5±0.22 to 8.6±0.16 and 4.60±0.16 to 8.40±0.16 respectively. The highest rating of colour, flavour, taste, texture and overall acceptability was seen in rice cooked with vinegar at 5.0% and lowest rating was seen in rice cooked with vinegar at 7.5%. Significant difference ($p \leq 0.05$) was observed from control to treatments.

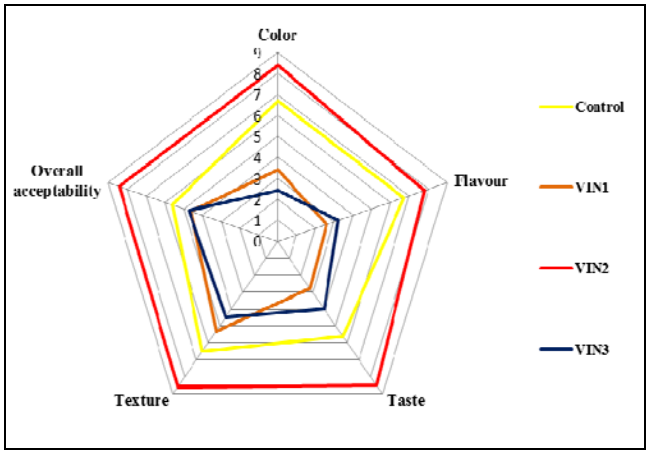

Fig 2: Sensory evaluation scores of rice cooked with vinegar (VIN)

The mean sensory evaluation scores for rice cooked by adding sunflower oil is presented in Figure. 3. Colour, flavour, taste, texture and overall acceptability of rice cooked with SFO and control ranged from 1.90±0.28 to 8.60±0.17, 1.90±0.38 to 8.70±0.15, 2.30±0.21 to 8.50±0.17, 4.80±0.36 to 8.40±0.17 and 3.20±0.20 to 8.70±0.15 respectively. The highest rating of colour, flavour, taste, texture and overall acceptability was seen in rice cooked with sunflower oil at 5.0%. There is no significant difference from control to SFO_1 for colour and overall acceptability.

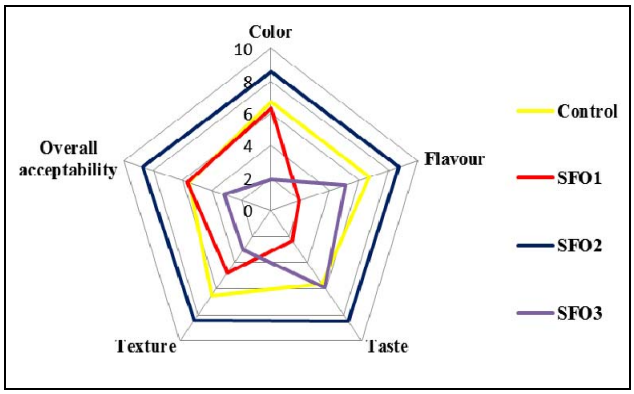

Fig 3: Sensory evaluation scores of rice cooked with sunflower oil (SFO)

The mean sensory evaluation scores for rice cooked by adding groundnut oil is presented in Figure.4. Colour, flavour, taste, texture and overall acceptability of rice cooked with GNO and control ranged from 5.10±0.10 to 8.70±0.15, 2.50±0.22 to 8.20±0.25, 3.60±0.16 to 8.60±0.16, 2.20±0.24 to 7.10±0.23 and 4.70±0.15 to 7.80±0.20 respectively. The highest rating of colour, flavour, taste, texture and overall acceptability was seen in rice cooked with groundnut oil at 7.5%. Significant difference (p≤0.05) was observed from control to treatments.

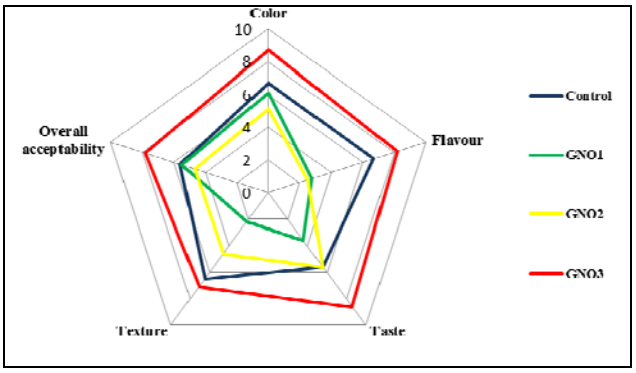

Fig 4: Sensory evaluation scores of rice cooked with groundnut oil (GNO)

The mean sensory evaluation scores for rice cooked by adding rice bran oil is given in Fgure.5. Colour, flavour, taste, texture and overall acceptability of rice cooked with RBO and control ranged from 3.50±0.16 to 8.70±0.15, 2.80±0.20 to 8.60±0.16, 3.80±0.24 to 8.30±0.21, 4.50±0.22 to 8.40±0.16 and 3.30±0.15 to 7.80±0.20 respectively. The highest rating of colour, flavour, taste, texture and overall acceptability was seen in rice cooked with rice bran oil at 5.0%. Significant difference (p≤0.05) was observed from control to treatments.

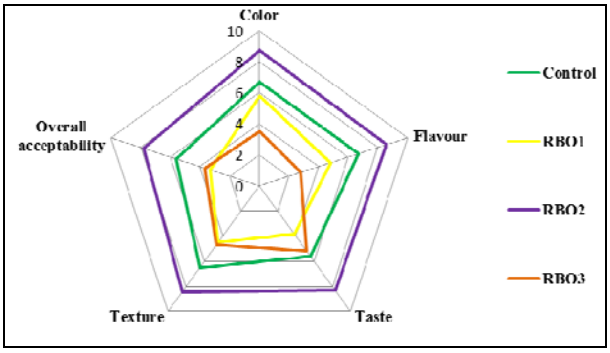

Fig 5: Sensory scores of rice cooked with rice bran oil (RBO)

Rice cooked with salt at 2.5% level, vinegar at 3% level, SFO and RBO at 5% level and GNO at 7.5% level had highest overall acceptability score and were analysed further for chemical properties and cooking quality characteristics.

Chemical quality characteristics of rice cooked by adding selected ingredients

The alkali spreading value (ASV) for rice cooked with selected ingredients ranged from 2.99±0.01 to 3.90±0.01 with a mean of 3.36 and rated as low ASV variety. In rice cooked with different ingredients, highest ASV was observed in rice cooked with GNO (3.90±0.01) followed by rice cooked with SFO (3.67±0.08). Lowest ASV was observed forrice cooked with vinegar (2.99±0.01). There was no significant difference observed from control (3.00±0.00) to rice cooked with VIN (2.99±0.01) and rice cooked with Salt (3.12±0.01). Compared to control significant difference (p≤0.05) was observed in rice cooked with GNO, SFO and RBO and also within the treatments (Table 2). When compared with control 5% increase in ASV for rice cooked with salt was observed, whereas significantly decreased for VIN (1%) and significant increase (p≤0.005) was observed for SFO (20%), GNO (25%) and RBO (15%) was seen (Figure 6).

These results were in conformity with Kaur *et al*. (2011) who studied physicochemical properties of newly developed basmati and non-basmati varieties of rice and reported that ASV was highest for rice variety PB 1121(8.00) and lowest for P 44 (3.75) variety.

Dipti *et al*. (2002) [8] studied Physico-chemical and cooking properties of six fine rice varieties. The highest alkali spreading value was found in Basmati PNR (3.9) and the lowest in Basmati 4488 (3.0)

Acidity ranged from 0.0056±0.00 to 0.0083±0.00 and no significant difference was observed from control to all experimental samples and also within the treatments. When compared to control significant increase (p≤0.005) was observed for rice cooked with salt (15%), significant decrease for rice cooked with VIN (10%), SFO (20%), GNO 20% and for significant increase (p≤0.005) was observed for RBO (20%). The pH ranged from 5.85±0.03 to 8.34±0.04. It was highest for rice cooked with RBO (8.34±0.04) and lowest for control (5.85±0.03). Significant difference (p≤0.05) was observed between control and experimental samples as well as within the treatments (Table 2). When compared with control significant increase (p≤0.005) was observed in pH for rice cooked with salt (25%), VIN (15%), SFO (22%), GNO (30%) and RBO (31%) (Figure 6).

Gelatinization temperature (GT) was highest for rice cooked with VIN (74°C±0.00) followed by control (71°C). GT was lowest in rice cooked with SFO (55°C±0.00), GNO (50°C±0.00) and RBO (55 °C±0.0) and significant difference was observed between the control and treatments (Table 2). Gelatinization temperature of rice cooked by adding salt (1%) significantly (p≤0.005) decreased, whereas rice cooked with VIN (5%), SFO (30%), GNO (40%) and RBO (40%) significantly (p≤0.005) higher compared to control (Figure 6).

Daomukda *et al*. (2011) [7] studied the effect of cooking methods on degree of gelatinization and ratio of rice to water on degree of gelatinization of rice. The degree of gelatinization of cooked rice ranged from 90.96% to 99.89%. The water to rice ratio of 2:1 resulted in the lowest decrease in the degree of gelatinization and yielded the hardest in texture, whereas in the water to rice ratio of 3:1 and 4:1 rice was completely cooked and yielded the desired texture. The degree of gelatinization of cooked rice tended to decrease

with decrease in the ratio of water to rice.

Organoleptic (cooking) quality characteristics of rice cooked by adding selected ingredients

Mean cooking time (CT) for rice cooked by adding different ingredients was 18min. and it ranged from 16.67±0.33 min to 19.33±0.33 min. Rice cooked without adding any ingredient (control) (19.33±0.67) and rice cooked with SFO (19.33±0.33) had the highest cooking time. The lowest cooking time was observed for rice cooked with salt (16.67±0.33) and GNO (16.67±0.33) (Table 3). Significant decrease ($p \leq 0.005$) in cooking time from control to all experimental samples was observed and no significant difference observed within the treatments. When compared with control cooking time in rice cooked by adding selected ingredients were significantly ($p \leq 0.005$) decreased for salt (15%), VIN (10%), GNO (15%) and RBO (10%) (Figure 7).

Similar results were reported by Rasool *et al*. (2015) [12]. It was reported that cooking time of milled rice varied from 22 to 27 min. A maximum cooking time of 27 min was recorded for K-448 variety and the minimum (22min) for K-39. The difference in cooking time among the cultivars may be due to differences in amylose content.

Significant difference ($p \leq 0.005$) was seen in elongation ratio (ER) of rice cooked by adding different ingredients and it ranged from 1.14±0.02 to 2.21±0.01. Lowest grain elongation was seen in rice cooked with vinegar (1.14±0.02) and highest ER in rice cooked with SFO (2.10±0.01) and RBO (2.21±0.01) (Table 3). When compared to control elongation ratio was significantly ($p \leq 0.005$) increased for rice cooked with salt (35%), SFO (40%), GNO (30%) and RBO (40%) and decreased 5% in VIN (Figure 7). Low ER might be due to high gelatinization temperature (74°C) which causes less ER during cooking than low and intermediate gelatinizing rice varieties. Higher elongation ratio is preferred than lower elongation ratio for quality of cooked rice. Elongation of rice can be influenced by l/b ratio and the amylose content (Danbaba *et al*., 2011) [6].

Length/breadth ratio after cooking showed significant difference ($p \leq 0.005$) among rice cooked with selected ingredients and ranged from 2.62±0.009 to 3.40±0.04. Significantly highest L/B was seen in rice cooked with RBO (3.40±0.04) and lowest in rice cooked with VIN (2.62±0.009) (Table 3). When compare to control significant ($p \leq 0.005$) increase was observed in L/B for rice cooked with VIN (5%), SFO (15%), GNO (10%) and RBO (20%) (Figure 7). Higher L/B after cooking is a good quality and width-wise increase is not a desirable characteristic in high quality rice and in general people prefer the varieties that expand more in length than in breadth (Choudhary, 1979) [4].

Water uptake ratio during cooking rice by adding selected ingredients ranged from 2.31±0.01g/ml to 3.48±0.01g/ml. Rice cooked by adding RBO (3.48±0.01g/ml) was observed maximum water uptake value followed by rice cooked with GNO (3.41±0.01g/ml) and rice cooked with VIN (2.31) had lowest water uptake value. Significant difference ($p \leq 0.005$) was observed between control and all treatments except for rice cooked with salt (2.45±0.01g/ml) and VIN (2.31±0.01g/ml) compared to control (2.38±0.01g/ml) (Table 3). Water uptake ratio of rice cooked with salt (1%), VIN (1%) low, SFO (20%), GNO (25%) and RBO (30%) was significantly ($p \leq 0.005$) increased (Figure 7).

Water uptake ratio varied from 2.03 to 2.45 g/g. A maximum water uptake ratio of 2.45 g/g was seen in K-448 variety. Elongation ratio ranged from 1.29 to 1.53. K-448 had the highest ER, whereas K-39 had the lowest ER value (Rasool *et al*. 2015) [12].

Gruel loss during cooking was maximum in rice cooked with salt (3.23±0.02g/g) and minimum was observed in rice cooked with RBO (2.18±0.01) (Table 3). When compared to control significant increase ($p \leq 0.005$) was seen in gruel loss for rice cooked with salt (1%) and significant ($p \leq 0.005$) decrease was observed with VIN (5%), SFO (20%), GNO (30%) and RBO (50%) compared to control (Figure 7).

Danbaba *et al*. (2011) [6] reported that solid loss ranged from 0.80% (*Ofada* 8) to 2.10% (*olfada* 9 and in *Ofada* 3) with an average of 1.25%. Rasool *et al*. (2015) [12] reported that solid loss in gruel ranged from 1.33% to 1.66%. K-39 had the highest gruel solid loss of 1.66% and K-448 variety had 1.33%. Solids in cooking water may be correlated with amylose content (r = -0.82) and might be related to stickiness of cooked rice.

Table 2: Chemical quality characteristics of rice cooked by adding selected ingredients

S. No.	Samples	ASV	Acidity	pH	G.T
1.	Control	3.00^{a}±0.00	0.067^{a}±0.00	5.85^{a}±0.03	71.33^{d}±1.33
2.	Salt (2.5%)	3.12^{ab}±0.01	0.057^{b}±0.00	7.83^{b}±0.03	70.00^{cd}±0.00
3.	VIN (3%)	2.99^{a}±0.01	0.060^{c}±0.00	6.57^{c}±0.07	74.00^{e}±0.00
4.	SFO (5%)	3.67^{d}±0.08	0.056^{d}±0.00	7.61^{d}±0.00	55.00^{bc}±0.00
5.	GNO (7.5%)	3.90^{e}±0.01	0.083^{e}±0.00	8.26^{e}±0.01	50.00^{a}±0.00
6.	RBO (5%)	3.53^{c}±0.03	0.083^{f}±0.00	8.34^{f}±0.04	55.00^{b}±0.00
7.	Mean	3.36	0.06	7.41	62.55
8.	CD	0.11	0.02	0.12	1.72
9.	SE of mean	0.08	0.00	0.22	2.30
10.	CV (%)	1.83	20.90	0.90	1.51

Note: Values are expressed as mean ± standard deviation of three determinations. Means within the same column followed by a common letter do not significantly differ at $p \leq 0.05$

Control: Rice cooked without adding any ingredient
Salt: Rice cooked by adding salt
VIN: Rice cooked by adding vinegar
SFO: Rice cooked by adding sunflower oil
GNO: Rice cooked by adding groundnut oil
RBO: Rice cooked by adding rice bran oil

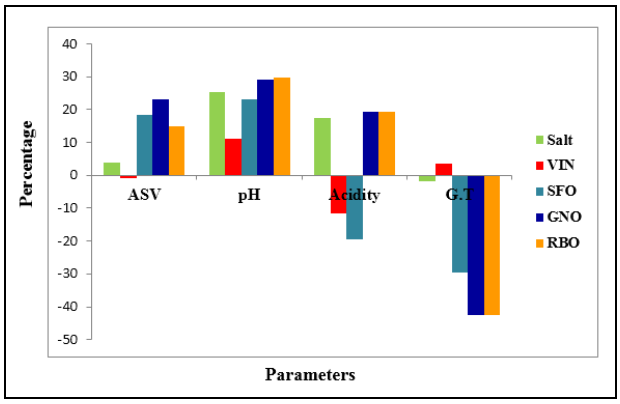

Fig 6: Percentage change in chemical quality characteristics of rice cooked by adding selected ingredients

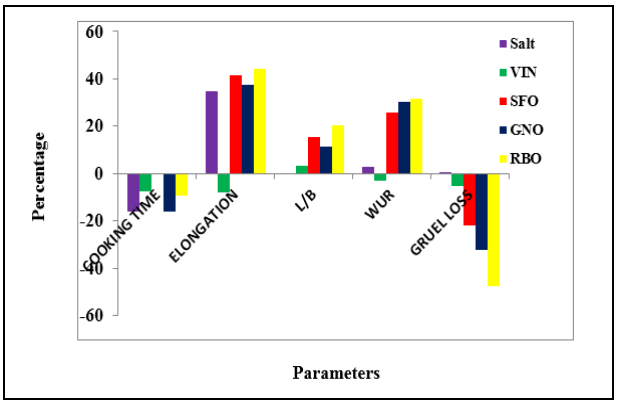

Fig 7: Percentage change in cooking quality characteristics of rice cooked by adding selected ingredients

Table 3: Mean organoleptic (cooking) quality characteristics of rice cooked by adding selected ingredients

S. No.	Samples	Cooking time (min)	Elongation ratio (ml/g)	L/B	WUR (g/ml)	Gruel loss (%)
1.	Control	$19.33^{d}\pm0.67$	$1.23^{b}\pm0.01$	$2.71^{cd}\pm0.02$	$2.38^{a}\pm0.01$	$3.22^{ef}\pm0.06$
2.	Salt (2.5%)	$16.67^{a}\pm0.33$	$1.89^{c}\pm0.02$	$2.71^{bc}\pm0.01$	$2.45^{ab}\pm0.01$	$3.23^{f}\pm0.02$
3.	VIN (3%)	$18.00^{b}\pm0.00$	$1.14^{a}\pm0.02$	$2.62^{a}\pm0.009$	$2.31^{a}\pm0.01$	$3.06^{d}\pm0.03$
4.	SFO (5%)	$19.33^{cd}\pm0.33$	$2.10^{e}\pm0.01$	$3.20^{f}\pm0.003$	$3.21^{b}\pm0.10$	$2.64^{c}\pm0.02$
5.	GNO (7.5%)	$16.67^{a}\pm0.33$	$1.96^{d}\pm0.01$	$3.06^{e}\pm0.007$	$3.41^{c}\pm0.01$	$2.43^{b}\pm0.02$
6.	RBO (5%)	$17.67^{ab}\pm0.33$	$2.21^{f}\pm0.01$	$3.40^{g}\pm0.04$	$3.48^{d}\pm0.01$	$2.18^{a}\pm0.01$
7	Mean	17.9444	1.7600	2.9494	2.8733	2.7972
8.	CD	1.10	0.03	0.05	0.14	0.05
9.	SE of mean	0.31	0.10	0.07	0.12	0.10
10.	CV (%)	3.32	0.85	0.930	2.74	1.14

Note: Values are expressed as mean ± standard deviation of three determinations.
Means within the same column followed by a common letter do not significantly differ at $p< 0.05$
Control: Rice cooked without adding any ingredients
Salt: Rice cooked by adding salt
VIN: Rice cooked by adding vinegar
SFO: Rice cooked by adding sunflower oil
GNO: Rice cooked by adding groundnut oil
RBO: Rice cooked by adding rice bran oil

Conclusion

There are many methods of cooking rice depending on individual local eating culture. The results of the study showed that the cooking rice by adding different ingredients significantly affected chemical composition, physicochemical properties and organoleptic quality of cooked rice. Varietal differences such as grain size, shape, 1000 kernel weight and bulk density will have influence on the grain quality. Grain quality evaluation always helps consumers to select better rice varieties. Rice cooked with salt at 2.5% level, vinegar at 3% level, SFO and RBO at 5% level and GNO at 7.5% level had highest overall acceptability score.

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