Full Length Research Article

Formulation and Quality Evaluation of Ready-to-Reconstitute Value Added Health Mix Using Navara Rice (Shastika Shali)

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Abstract

Navara rice, a highly ethnic Oryza species known for its medicinal properties and used in various ayurvedic treatments to cure numerous diseases. Navara rice has played an inevitable part in ayurvedic medicine since the 15th century. This brown rice variety was predominantly used in Panchakarma treatment and for other pathological states like snake bites, psoriasis, ulcers, urinary tract disorders etc., The value-added health mix was evaluated with comparison to control (100% raw rice) and the best accepted variation treatment (T_5 – 100% Navara rice) to analyze the physico-chemical and nutritional properties. The developed health mix was rich in energy, protein, fat, carbohydrate, iron, and ash. The protein (30.3g/100g) and iron (4.89mg/100g) content of the health mix was double when compared to control.

Key words: Navara rice, Health mix, Value-added, Oryza, Formulation

Navara (*Oryza sativa* L.) is an endemic rice cultivar of Kerala. "sastika" rice got its name as it matures at 60 days. It is cultivated for its medicinal properties and is an important ingredient of navarakkizhi in Ayurvedic treatment. It is also used as weaning food. The color of husk varies from straw to black through brown to purple like Karutha navara and velutha navara are referred to as the husk color, says [5]. Navara rice is one among the unique varieties of oryza group with many high lightened medicinal and nutritious benefits. Navara rice got its geographical identification in the year 2007 and it is predominantly used in Kerala. This wholesome rice variety is used to treat many conditions like ulcers, psoriasis, neuromuscular disorders and even for snake bites. Incorporating this rice variety in the health mix adds more value and contributes to spreading awareness about this flourishing rice variety among upcoming generations. To develop and standardize ready-to-reconstitute value added health mix using Navara rice.

▪ To analyze the organoleptic, physico-chemical, nutritional, microbial properties and shelf life of ready-to-reconstitute value added health mix.

MATERIALS AND METHODS

Formulation and standardization

The health mix was prepared in the food science laboratory of the Department of Home Science, Shrimathi Devkunvar Nanalal Bhatt Vaishnav college, Chennai. Health mix was prepared by:

- Dry roasting the Navara rice flour
- Dry roasting the sprouted green gram dhal
- Dry roasting the pumpkin seeds
- Grinding dal and pumpkin seed separately to a dry fine powder.
- Mix the flours evenly to prepare the health mix.
- The control (C) was prepared using raw rice; T_1, T_2, T_3, T_4, T_5 treatments were prepared using navara rice 20%, 40%, 60%, 80%, 100% respectively.

Table 1 Variation proportions of ingredients

Samples	Raw rice (g)	Navara rice (g)	Sprouted and dried green gram dhal (g)	Pumpkin seeds (g)	Palm sugar (g)	Ginger powder (g)
Control	100	-	30	20	10	2
T_1	80	20	30	20	10	2
T_2	60	40	30	20	10	2
T_3	40	60	30	20	10	2
T_4	20	80	30	20	10	2
T_5	-	100	30	20	10	2

Fig 1 Ingredients (pumpkin seeds, sprouted green gram dal, navara rice flour, palm sugar, dried ginger powder)

RESULTS AND DISCUSSION

Quality evaluation

This study covered sensory acceptability (using 9 - hedonic scale Scorecard), nutrient analysis (using Laboratory Techniques), physico-chemical properties and storage studies of developed health mix. The nutrients such as carbohydrate, protein, fat, iron, ash is tested in the laboratory and the results are analyzed.

Fig 2 Treatment variations

Sensory evaluation of developed product

Table 2 Mean acceptability scores

Sensory attributes	Control	Treatment I	Treatment II	Treatment III	Treatment IV	Treatment V
Color	7.9 ± 0.21	7.75 ± 0.36	7.9 ± 0.12	8.04 ± 0.22	8.3 ± 0.30	8.9 ± 0.11
Taste	7.2 ± 0.33	7.6 ± 0.63	7.7 ± 0.14	7.8 ± 0.18	8.01 ± 0.09	8.85 ± 0.45
Flavor	7.0 ± 0.25	7.3 ± 0.31	7.6 ± 0.72	7.9 ± 0.45	8.0 ± 0.18	8.8 ± 0.65
Texture	7.8 ± 0.21	7.8 ± 0.43	7.9 ± 0.44	8.01 ± 0.33	8.2 ± 0.42	8.7 ± 0.43
Appearance	7.5 ± 0.34	7.2 ± 0.54	7.3 ± 0.64	8.0 ± 0.67	8.1 ± 0.24	8.65 ± 0.54
Overall acceptability	7.2 ± 0.46	7.6 ± 0.76	7.9 ± 0.54	8.06 ± 0.65	8.3 ± 0.63	8.85 ± 0.21

Statistical inference

The statistical inference (mean score value, standard deviation and t -test) of the control and treatment V was calculated and examined. Treatment V has got the highest mean acceptability scores as compared to other treatments.

Organoleptic evaluation

The t -test value at 0.05% significance level for control and Treatment V health mix - Color was 6.90, taste was 6.45, flavor was 5.72, texture was 5.21, appearance was 6.05 and overall acceptability was 6.90. The t value of flavor and texture was lower than the other sensory attributes.
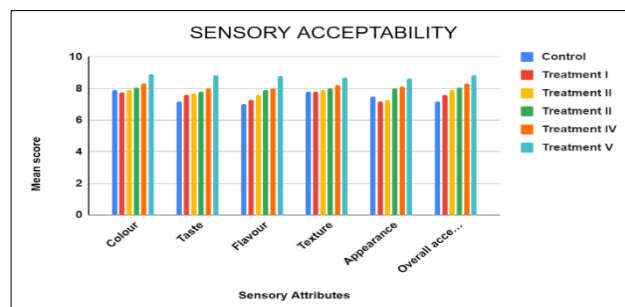

Fig 3 Sensory acceptability of score chart of control and treatments

Table 3 Statistical inference of control and treatment - V health mix

Sensory attributes	Types	Mean	Standard deviation (SD)	t - value (0.05%) [d.f/υ=19 (n-1)]	Rejection (H_0) / acceptance (H_a)
Color	Control	7.9	0.56	6.90*	Rejected
	Treatment V	8.9	0.3		
Taste	Control	7.2	0.65	6.45*	Rejected
	Treatment V	8.85	0.23		
Flavor	Control	7.0	0.45	5.72*	Rejected
	Treatment V	8.8	0.6		
Texture	Control	7.8	0.81	5.21*	Rejected
	Treatment V	8.7	0.43		
Appearance	Control	7.5	0.58	6.05*	Rejected
	Treatment V	8.65	0.55		
Overall acceptability	Control	7.2	0.39	6.90*	Rejected
	Treatment V	8.85	0.45		

*t-value indicates that significant difference at 5% level significance
Critical value- 2.50
Control- 100 % Raw rice
Treatment V- 100% Navara rice

Statistical conclusion

As per the above table, the calculated t-values of the sensory attributes such as colour, taste, texture, appearance and overall acceptability are higher than all the treatment variations including control. So, Treatment - V is compared with the control for further objective evaluation. Some hypotheses were framed with regard to the same. They are:

Table 4 Statistical conclusion

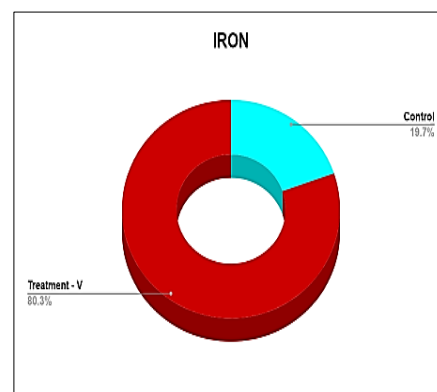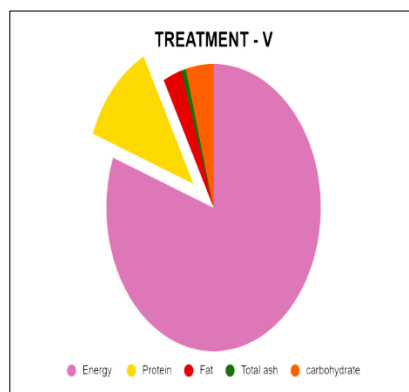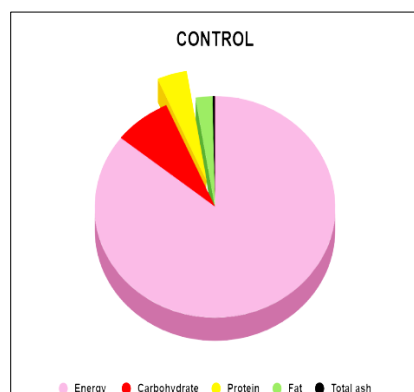| Hypothesis	Null hypothesis (H₀)	Alternate hypothesis (H_a)	Conclusion
I - Colour	There is no significant difference in sensory attribute colour between control and T5.	There is a significant difference in sensory attribute colour between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of colour between control and Treatment - V. It shows that Treatment - V has higher sensory attribute colour which is more than the control.
II - Taste	There is no significant difference in sensory attribute taste between control and T5.	There is a significant difference in sensory attribute taste between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of taste between control and Treatment - V. It shows that Treatment - V has higher sensory attribute taste which is more than the control.
III - Flavour	There is no significant difference in sensory attribute flavour between control and T5.	There is a significant difference in sensory attribute flavour between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of flavour between control and Treatment - V. It shows that Treatment - V has higher sensory attribute flavour which is more than the control.
IV - Texture	There is no significant difference in sensory attribute texture between control and T5.	There is a significant difference in sensory attribute texture between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of texture between control and Treatment - V. It shows that Treatment - V has higher sensory attribute texture which is more than the control.
V - Appearance	There is no significant difference in sensory attribute appearance between control and T5.	There is a significant difference in sensory attribute appearance between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of appearance between control and Treatment - V. It shows that Treatment - V has higher sensory attribute appearance which is more than the control.
VI - Overall acceptability	There is no significant difference in sensory attribute overall acceptability between control and T5.	There is a significant difference in sensory attribute overall acceptability between control and T5.	The alternate hypothesis is accepted because the table value (2.50) showed that there is a significant difference of overall acceptability between control and Treatment - V. It shows that Treatment - V has higher overall acceptability which is more than the control.

Proximate composition of health mix

The proximate composition of Control and Treatment V was examined. The nutrients such as energy, carbohydrates, protein, fat and total ash were evaluated and analyzed. The result of the same has been discussed below:

Table 5 Proximate composition

Product	Energy (Kcal/100g)	Carbohydrate (gm/100g)	Protein (gm/100g)	Fat (gm/100g)	Total ash (gm/100g)
Control	261.3	23.5	12.3	6.9	1.03
Treatment - V	294.5	26.7	30.37	7.3	1.96

Fig 4 Nutrient composition of control health mix

Fig 5 Nutrient composition of Treatment - V health mix

Fig 6 Iron content of control and Treatment - V

Mineral content

The iron content of control and Treatment - V (100% raw rice; 100% navara rice respectively) was described below:

- Control - 1.20mg
- Treatment V - 4.89mg

Table 6 Nutrient composition - Conclusion

Nutrients	Conclusion
Energy	The energy content of Treatment - V was 294.5 Kcal/100g which was *higher* than the control (261.3 Kcal/100g) variation developed. [2] revealed in his experiment that navara rice has 1628 KJ/100g.
Carbohydrate	The carbohydrate content of Treatment - V was 26.7 g/100g which was *higher* than the control (23.5 g/100g).
Protein	The Protein content of Treatment - V was 30.37 g/100g which was *extremely higher* than the control (12.3 g/100g). In a nutrient evaluation and phytochemical analysis and micropropagation in navara rice. [7] revealed that navara rice possesses upto 8.8% of the total protein content of the rice.
Fat	The fat content of Treatment - V was 7.3 g/100g which was *significantly higher* than the control (6.9 g/100g). [1] studied the muscle nourishing property of navarakizhi and pinda sweda which showed that phytochemicals and fatty acids have a great influence.
Total Ash	The total ash content of Treatment - V was 1.96 g/100g which was *higher* than the control (1.03 g/100g). The major nutrients in dehusked navar rice are Ca (10.3%), Fe (2.81%), Zn (2.78%), P (197%) says [7].
Iron	The Iron content of Treatment - V was 4.89 mg/100g which was *higher* than the control (1.2 mg/100g).

Physico-chemical properties

Physical properties of rice

Table 7 Physical properties

Navara rice		Conclusion
Thousand grain weight	38.06 ± 0.27	[3] said that the Thousand grain weight of seeds varies during sowing and on natural mass variation.
Thousand grain volume	36.03 ± 0.12	[6] explained that volume of grain ranges from 16.2 to 22.02 mm3
Bulk Density	1.1 ± 0.18	[6] also enumerated that brown rice's bulk density ranges from 0.77 - 0.7 g/cm3
Hydration capacity	2.36 ± 0.15	[11] studied that water uptake in brown rice with no cooking is significantly
Hydration index	1.18 ± 0.27	evident.
Swelling capacity	3.96 ± 0.36	
Size	0.6 ± 0.18	The length, width and thickness for the brown rice kernels ranged from 5.35 to 7.25
a) Length	0.3 ± 0.12	mm, 1.95 to 2.3 mm and 1.64 to 1.77 mm respectively, says [10].
b) Thickness		

Functional properties

Table 8 Functional properties

Navara rice		Conclusion
pH	6.36	[9] developed dosa batter using navara rice. They highlighted pH of the product is highly essential
Titratable acidity	1.66%	While studying the physicochemical properties of brown rice flour the titratable acidity of the rice was very essential says [4]
Moisture	1.63%	The need and importance of moisture content of the food product was studied by [8]

Storage study
Microbial study

The purpose of microbial analysis of a food product is to help with the identification and restriction of harmful microorganisms, which can spoil foods and ensure safety from food borne diseases. In this study microbial experimentation contains total bacterial and total yeast and mold growth and the results of control and treatment V was discussed below:

Total bacterial count

Table 9 Total bacterial count

Variations	Total Bacterial Count (cfu/gm)		
	0th day	10th day	15th day
Control	Nil	0.4×10^2	0.7×10^2
Treatment V	Nil	0.2×10^2	0.5×10^2

Yeast and mold

Table 10 Total plate count

Variations	Yeast and mold (cfu/gm)		
	0th day	10th day	15th day
Control	1.2×10^2	1.6×10^2	2.4×10^2
Treatment V	1.0×10^2	2.5×10^2	4.0×10^2

From the above analysis, it was concluded that the bacterial, yeast and mold growth of both control and treatment V health mix was good and acceptable even during the 15th day. The treatment V (100% navara rice) health mix contains more microbial growth when compared to control health mix. It may be due to the preparation of the flour process i.e., through grinding or any other preparation.

Shelf-life study

Table 11 Shelf-life comparison between control and treatment V health mix

Shelf-life days	At room temperature		At Refrigerator	
	Control	Treatment V	Control	Treatment V
0	No Change	No Change	No Change	No Change
10	No Change	No Change	No Change	No Change
15	No Change	No Change	No Change	No Change
25	Raw rice Flavor	No Change	No Change	No Change
30	Spoiled	Nutty Flavor	Raw rice Flavor	No Change

The best variation treatment V (T5) was stored in an airtight container for more than a month and the product was safe for consumption even after 30 days especially when stored in a refrigerator. It shows the good acceptability of T5.

CONCLUSION

The result of this present study indicated the following:
- In this study, we found that navara rice is highly medically acknowledged and nutritious to include in our daily diet.
- With increased public awareness this kind of healthy brown rice variety can be brought back to the dietary regimen.
- Several studies elucidate that navara is one amongst the ancient rice grains which was used even before 2500 years which shows its genetic significance.
- Addition of this nutritious navara rice in our diet is highly preventive and a curative behavior.

The use of navara rice also brings back the indigenous rice varieties back to the market which is one of the significant advantages for the current population.

Fig 7 Stored health mix powder

Table 12 Summarization

Test	Control	Treatment - V
Sensory Acceptability	Mean score of control was 7.2 and it was compared with the other developed variations	Mean score of Treatment - V (100% navara rice) was 8.85 and it was *higher* than control and all other variations in all aspects of sensory attributes
Nutrient Analysis	The control sample was prepared with 100% raw rice flour and its nutrient composition was examined Energy - 261.3 Kcal/100g Carbohydrate - 23.5g/100g Protein - 12.3g/100g Fat - 6.9g/100g Total Ash - 1.03g/100g Iron - 1.2 mg/100g	The Treatment - V sample was prepared with 100% navara rice flour and its nutrient composition was examined. It was *evidently higher* when compared to control. Energy - 294.5 Kcal/100g Carbohydrate - 26.7g/100g Protein - 30.3g/100g Fat - 7.3g/100g Total Ash - 1.96g/100g Iron - 4.89 mg/100g
Physico chemical properties a. Physical properties of rice	Thousand grain weight - 30.06 Thousand grain Volume - 31.03 Bulk density - 0.8 Hydration capacity - 2.02 Hydration index - 1.02 Swelling capacity - 3.12 Size - Length - 0.4 Width - 0.2	Thousand grain weight - 38.06 Thousand grain Volume - 36.03 Bulk density - 1.1 Hydration capacity - 2.36 Hydration index - 1.18 Swelling capacity - 3.96 Size - Length - 0.6 Width - 0.3
b. Functional properties of health mix	pH - 6.4 Titratable acidity - 1.54% Moisture - 1. 44%	pH - 6.36 Titratable acidity - 1.66% Moisture - 1.63%
Microbial study a. Total Bacterial Count	The growth of bacteria was at a safer limit on the 15th day. 0th day - nil 10th day - 0.4×10^2 15th day - 0.7×10^2	The growth of bacteria was at a safer limit on the 15th day. 0th day - nil 10th day - 0.2×10^2 15th day - 0.5×10^2
b. Total yeast and mold	The growth of yeast and mold was on safer limit on the 15th day 0th day - 12 cfu/gm 10th day - 16 cfu/gm 15th day - 24 cfu/gm	The growth of yeast and mold was on a safer limit on the 15th day. 0th day - 10 cfu/gm 10th day - 25 cfu/gm 15th day - 40 cfu/gm
Shelf-life study	Room temperature - Got spoiled. Refrigerator - Raw rice flavor	Room temperature - Nutty flavor Refrigerator - Safe for consumption.

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