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Organoleptic attributes of functional food mix

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Abstract
Quinoa and amaranth were soaked in hot water overnight, shade dried and popped. The popped grains were then ground into quinoa and amaranth flour to obtain functional food mix. The developed functional food mix was then subjected to sensory evaluation by 21 semi trained panel members using nine-point hedonic scale. Sensory attributes of quinoa and amaranth functional food mix at 25 percent incorporation level ranked no. 1 with overall acceptability score of 8.90 and 8.60 respectively. Therefore, these can be used as excellent alternative, dietary sources to enrich the beverages to meet the nutritional requirements of athletes which is need of hour by most of the athletes. Quinoa can be used as one of the best protein source for low cost nutrition and sports mix which has got very good bioavailable protein, minerals and complex carbohydrates with low glycemic index. People suffering from non-communicable diseases can also consume this functional food mix.

Keywords: Quinoa, grain amaranth, functional food mix, organoleptic and acceptability index

Introduction
The quest for naturally-grown alternative grains that present a good nutritional profile and adaptability to adverse weather conditions has increased in importance over the last years. Amaranth (*Amaranthus caudatus*) and quinoa (*Chenopodium quinoa*) are originally from the Andes of South America where they have remained a staple since Pre-Hispanic times. Due to their protein quality which is comparable to casein (Ranhotra *et al.*, 1993) [6]; high content of fibre and bioactive compounds (Repo-Carrasco, 2011) [7], these gluten-free grains are formidable food alternatives. In sports nutrition, the consumption of hydrolyzed protein supplements has gained relevance due to their ability to modulate the anabolism of skeletal muscle proteins, improve sports performance, influence the control of body mass, and accelerate the digestion and absorption of proteins and increasing the availability of amino acids. These products are obtained from protein concentrates or isolates by enzymatic hydrolysis. These concentrates are expensive and have many health concerns mainly bloating. These are compelling drivers for alternative protein source to the requirement of sports person. These days plant based proteins are receiving greater importance. Obtaining hydrolysates from vegetable flours could provide advantages in the functional and nutritional properties of the product obtained due to the presence of fibres and minerals in the flours.
Quinoa has gained attention as an alternative crop due to its ability to thrive in stressful conditions and has been marketed as a highly nutritious "superfood." It belongs to the Chenopodiaceae family and is known as the "mother grain" in the Inca language. Quinoa flour contains a well-balanced combination of essential minerals like potassium, sodium, magnesium, calcium, and even soluble iron, as well as vitamins B3, B6, B9, and C. Additionally, it is rich in natural antioxidants, including phenolic compounds and flavonoids (El-Sohaimy *et al*., 2018) [3]. Quinoa proteins are highly digestible, with a digestibility level of approximately 86.85±0.83%, making it suitable for various food and beverage applications (El-Sohaimy *et al*., 2015) [11]. In the research conducted by Stikic *et al*. (2012) [10], an attempt was made to remove the seed coat of quinoa seeds through a dehulling process to eliminate saponins. However, this treatment had some notable effects on the composition of the quinoa seeds. It led to a decrease of approximately 2% in protein content, 3% in ash content, and a 4% reduction in fiber content. Additionally, the concentration of certain minerals, including calcium and sodium, was found to decrease as well. Studies involving animal feeding have confirmed that quinoa protein is highly digestible. When considering unprocessed quinoa proteins, an impressive 91.6% of them can be absorbed by the body. Additionally, subjecting quinoa to heat treatments like cooking significantly enhances protein digestibility, elevating it

to 95.3% (Ruales *et al*., 2002) [8].
The remarkable bioavailability of quinoa can be attributed in part to its relatively low content of trypsin inhibitors, ranging from 1.36 to 5.04 TIU/mg (Vega-Galvez *et al*., 2010) [12]. These inhibitors are known to hinder the enzymatic digestion and absorption of proteins. Furthermore, both Hydrolysed Quinoa Flour (HQF) and Hydrolysed Broad Bean Flour (HBF) contain substantial levels of essential amino acids. Specifically, HQF has 6415.13 mg/100 g, while HBF boasts an even higher content at 11901.71 mg/100 g. Notably, both flours are rich in branched-chain amino acids, which are essential in sports nutrition for enhancing athletic performance and reducing the onset of fatigue. Additionally, these hydrolyzed flours are abundant in glutamic acid, a precursor to glutamine. This amino acid is crucial for replenishing muscle glycogen stores and preventing muscle mass loss, making it valuable in post-exercise recovery.
Amaranth is a pseudo-cereal that has a long history of cultivation by ancient civilizations like the Aztecs, Incas, and Mayas in Latin America. This grain belongs to the dicotyledonous class within the Amaranthaceae family. Over the past two decades, there has been a growing interest in promoting amaranth as a valuable addition to human nutrition due to its reported nutritional value and health advantages. Amaranth grains are known for their exceptional nutritional quality, boasting roughly 15% protein content with a well-balanced profile of amino acids, including a high lysine content. They also consist of about 60% starch and 8% fat. With these nutritional attributes in mind, the goal of the article was to create a functional food blend by incorporating both quinoa and amaranth flour, with the aim of providing potential benefits for athletes.

Material and Methods

Procurement of raw materials: Ingredients like quinoa and chia seeds were sourced from Kilaru Naturals Pvt. Ltd. in Telangana. Grain amaranth was obtained from the Scheme Head and Scientist at the All India Co-ordinated Research Network on potential crops, UAS, GKVK, Bengaluru. Various other miscellaneous materials were purchased from the local market in Bengaluru.

Processing of ingredients

Quinoa and amaranth underwent a process involving soaking in hot water overnight, followed by shade drying and popping. These popped grains were subsequently ground to produce quinoa and amaranth flour, which were then used to create the functional food mix.

Sensory evaluation: The functional food mix that was created underwent a sensory evaluation process. This evaluation was conducted by a group of 21 semi-trained panel members, consisting of both staff and students from the Department of Food Science and Nutrition at the University of Agricultural Sciences, GKVK, Bengaluru. The assessment involved rating the developed formulations for attributes such as appearance, color, flavor, taste, texture, and overall acceptability. A nine-point hedonic scale, as described by Amerine *et al*. in 1965, was used for this evaluation. Based on the sensory evaluation results, the level of incorporation that received the highest level of acceptance was selected to formulate the functional food mix.

Statistical analysis: The data obtained was subjected for statistical analysis. Mean±SD was calculated. One-way ANOVA (Analysis of Variance) was used to analyze and interpret the data using SPSS software (version 16.0).

Results

Organoleptic evaluation of quinoa and amaranth functional food mix

Sensory attributes of quinoa functional food mix is depicted in Table 1. The appearance score was found to be significantly (p<0.05) high (8.70) for Q-25. Colour scores of quinoa flour ranged from 8.30 to 8.80 and results were found to be statistically significant (p<0.01). Q-25 scored significantly (p<0.01) high (7.90) flavour scores. 35 percent incorporation of quinoa flour (Q-35) had significantly (p<0.01) lowest taste (7.00) and textural (8.40) score. However 25 percent incorporation of quinoa flour (Q-25) ranked no. 1 with overall acceptability score of 8.90.
Sensory attributes of amaranth functional food mix is presented in Table 2. The sensory scores for appearance, colour, flavor, taste, texture and overall acceptability ranged from 7.90 to 8.50, 8.00 to 8.60, 7.10 to 8.00, 7.80 to 8.60, 8.20 to 8.60 and 7.90 to 8.60 respectively, The appearance score was found to be significantly (p<0.05) high (8.50) for A-25. Colour score of amaranth functional food mix was highest (8.60) for A-25. A-35 scored significantly (p<0.01) low (7.10) flavour scores. 25 percent incorporation of amaranth flour (A-25) had significantly (p<0.01) highest taste (8.60) and textural (8.60) score. However 25 percent incorporation of amaranth functional food mix (A-25) ranked no. 1 with overall acceptability score of 8.60.
Based on the acceptability scores quinoa (25%) and amaranth (25%) was selected for final product. Functional food mixwith quinoa flour (25g) and amaranth flour (25g) reconstituted with milk had significantly (p<0.01) acceptability index (85.74) compared to hot water (Fig. 1, 3).
A highly regarded functional food mix was assessed for consumer acceptance (Table 3) by 50 participants using the Food Action Rating Scale (FACT). The aim was to gauge the extent to which consumers liked or disliked the mixture when it was reconstituted with water and served to them. Nine statements were presented to assess consumer acceptability.
Among the various statements, it was observed that 32 percent of consumers expressed a strong desire to consume the mix whenever the opportunity arose. Additionally, 26 percent of respondents indicated that they would consume it very frequently, while 14 percent stated that they would eat it regularly. A smaller portion, 10 percent, mentioned that they liked the mixture and would consume it occasionally, and 8 percent stated they would eat it if it were available but wouldn't go out of their way to obtain it. Four percent of respondents expressed a willingness to eat the mix on special occasions, even if they didn't particularly like it and mentioned that they would hardly ever consume it. Only 2 percent of respondents said they would eat the mixture only if there were no other food choices available. This data suggests that the developed functional food mixture was well-received and acceptable to the majority of respondents.

Discussion

The average score obtained for overall acceptance of optimized quinoa-based cookie (Brito *et al*., 2015) [13] was 6.8, which is lesser than the score for quinoa functional food mix. The overall acceptability score reported by Kaur and Kaur (2017) [5] for cakes (7.54), cookies (7.46), muffins

(7.32), pies (7.78) and tarts (7.56) are lower compared to the values reported in the present study. Better acceptability score (8.90) obtained for functional food mix is due to the processing techniques employed to reduce the saponin and other anti-nutritional factors which adversely impacts on sensory parameters. The overall acceptability score given by the infant's mothers to the complementary food incorporated with 8 percent quinoa flour was higher (4.50; $p<0.05$) than those given to the 0 percent (control - 3.88) and 15 percent (3.00) (Ayseli *et al.*, 2020) [1]. The reason could be attributed to the low amount of total sugar present in the quinoa flour.

Gebreil *et al.* (2020) [14] revealed that, the highest overall acceptability score (8.20) for crackers was at 75 percent level incorporation of amaranth flour and for tortilla highest overall acceptability score (8.59) was at 25 percent level incorporation of amaranth flour. The overall acceptability score for tortilla was on par with the results of amaranth functional food mix incorporated with 25 percent amaranth flour (8.60). The semi-trained panelists assigned an average value of 8.1 and 8.4 in acceptability to the nutraceutical beverages from roasted and extruded amaranth flours (11% incorporation), respectively (Carrillo *et al.*, 2012) [15]. Based on the findings of the sensory analysis (as depicted in the figure), it was determined that chapattis achieved a commendable sensory acceptability score of 8.20 when wheat flour was substituted with amaranth flour at a level of 40% (Banerji *et al.*, 2017) [16]. These chapattis exhibited the characteristic nutty aroma and taste associated with amaranth. A similar nutty flavor was reported by Lorenz in 1981 [15] in bread that incorporated amaranth.

In our current study, the incorporation of amaranth flour into the functional food mix resulted in an even higher overall acceptability score. This could be attributed to the specific processing treatments applied, including soaking, drying, and popping, along with pre-treatments. These methods likely contributed to an enhanced flavor profile, reduced bitterness, elimination of earthy taste, and an overall increase in the product's acceptability. In a separate study, the acceptance of millet flaked snack bars was assessed through a survey involving 60 participants. The results revealed that 50% of the consumers expressed high satisfaction with the bars, with 46.7% rating their satisfaction level as very good. Only a small proportion, 1.7%, rated the bars as good or fair (Sohan *et al.*, 2021) [9].

Table 1: Sensory attributes of quinoa flour for functional food mix

Quinoa functional food mix	Appearance	Colour	Flavour	Taste	Texture	Overall Acceptability	Rank
Q-25	8.70±0.56^{a}	8.30±0.42^{a}	7.90±0.69^{a}	7.80±0.31^{a}	8.70±0.31^{a}	8.90±0.42^{c}	I
Q-30	8.50±0.48^{b}	8.50±0.42^{a}	7.40±0.33^{b}	7.50±0.66^{b}	8.50±0.31^{a}	8.50±0.48^{b}	II
Q-35	8.40±0.48^{b}	8.80±0.66^{b}	7.00±0.33^{b}	7.00±0.66^{c}	8.40±0.31^{b}	8.00±0.56^{a}	III
S.Em.±	0.49	0.53	0.49	0.46	0.51	0.48	
CD (5%)	1.24	0.89	0.97	1.01	0.82	0.91	
F value	4.55*	5.42**	9.24**	15.37**	11.04**	8.12**	

Q-25= 25 percent incorporation of quinoa flour
Q-30= 30 percent incorporation of quinoa flour
Q-35= 35 percent incorporation of quinoa flour
Values are expressed as Mean ± S.D., S.Em. ± Standard error of Mean
*Significant at $p\leq0.05$, ** $p\leq0.01$
Different alphabets superscript within a column indicate significant difference at 0.05 level by DMRT

Table 2: Sensory attributes of functional food mix

Amaranth functional food mix	Appearance	Colour	Flavour	Taste	Texture	Overall Acceptability	Rank
A-25	8.50±0.70^{a}	8.60±0.51^{a}	8.00±0.51^{a}	8.60±0.69^{a}	8.60±0.51^{a}	8.60±0.51^{b}	I
A-30	8.10±0.84^{b}	8.00±0.56^{b}	7.70±0.70^{c}	8.20±0.67^{ab}	8.20±0.63^{b}	8.10±0.56^{a}	II
A-35	7.90±0.74^{b}	8.00±0.96^{b}	7.10±0.50^{b}	7.80±0.57^{b}	8.20±0.73^{b}	7.90±0.64^{ab}	III
S.Em.±	0.55	0.49	0.43	0.44	0.45	0.42	
CD (5%)	0.78	1.15	0.78	0.96	0.84	0.82	
F value	5.96**	1.29**	11.84**	4.01**	5.24**	3.50*	

A-25= 25 percent incorporation of amaranth flour
A-30= 30 percent incorporation of amaranth flour
A-35= 35 percent incorporation of amaranth flour
Values are expressed as Mean ± S.D., S.Em. ± Standard error of Mean
*Significant at $p\leq0.05$, ** $p\leq0.01$
Different alphabets superscript within a column indicate significant difference at 0.05 level by DMRT

Table 3: Consumer acceptability of functional food mix using FACT scale N=50

Sl. No.	Opinion	Number of respondents	Percentage of total
1.	I would eat every opportunity that I had	16	32
2.	I would eat this very often	13	26
3.	I would frequently eat this	7	14
4.	I like this and would eat it now and then	5	10
5.	I would eat if available but would not go out of my way	5	8
6.	I don't like this but would eat this on an occasion	2	4
7.	I would hardly ever eat this	2	4
8.	I would eat this if there were no other food choices	1	2
9.	I would eat this only if forced	0	0
Total		50	100

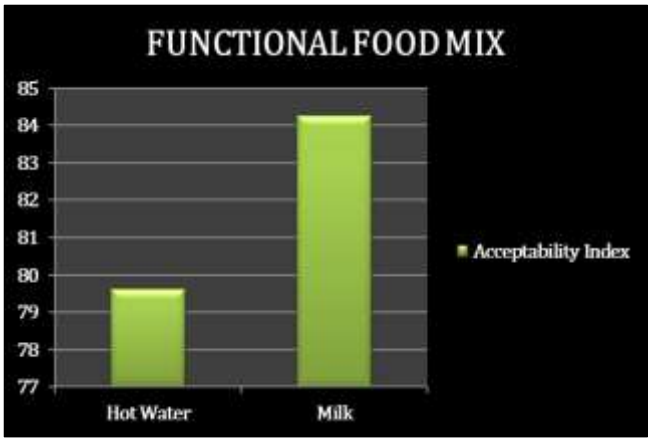

Fig 1: Acceptability Index of reconstituted functional food mix

Fig 2: Quinoa and amaranth based functional food mix

Fig 3: Functional food mix reconstituted with different fluids

Fig 4: Sensory evaluation of developed functional food mix and drink

Conclusion

The present study demonstrated that quinoa and amaranth at 25 percent level incorporation has provided acceptable product with very good score for appearance, colour, flavour, taste, texture and overall acceptability. Therefore, these can be used as excellent alternative, dietary sources to enrich the beverages to meet the nutritional requirements of athlete which is need of the hour.

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