Research Article

Fermented Quinoa Based South Indian snack Items

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Abstract
Quinoa (*Chenopodium quinoa wild*) belongs to the group of crops called pseudocereals. Current study aims to develop fermented quinoa incorporated snack items because fermentation turned into taken consideration as proper technique for grain processing due to its low rate, low energy requirements, with applicable and distinctive flavours for human consumption. Fermented quinoa was used to prepare snack items like foxtail quinoa laddu, guntapunugulu and murukulu. And incorporation was done in different proportions like 25%, 50%, 75% and 100%. Among the incorporated snack items were organoleptically evaluated by sensory attributes such as colour, texture, flavour, taste and overall acceptability. Among the proportions 25% was more acceptable in murukulu and foxtail laddu and guntapunugulu.

Keywords: Fermented quinoa, Snacks, Murukulu, Foxtail laddu and guntapunugulu

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Introduction

Preference of traditional snack items in India was more because of providing nutritious and easy preparation of snack items by using different commonly available ingredients [1]. Fermentation as a food processing technique is not a novel procedure. However, fermentation with proper starter cultures can reduce the use of artificial additives such as stabilizers, thickeners, or flavours [2].

Fermented foods have diverse of traditions and cultural preferences found in the different geographical areas, where they are produced. They have been consumed since ancient times due to their prolonged shelf life, reduced volume, shorter cooking times and superior nutritive value as compared to the non-fermented ingredients [3].

Among the traditional snack items in south India murukulu is a popular savoury snack. Murukku is usually crafted from a mixture of black gram dal and rice flour, salt, and flavourings along with chili, asafoetida, cumin seeds and other spices. Traditionally the murukkus had been prepared by frying hence baking murukkus can make them much less calorie dense product [4]. Traditional sweet like ladoo the use of mixture of cereals, millets and sprouted pulses could symbolize the powerful utilization and optimization of those regionally grown cheaper grains and grams. People may be fed on anywhere and every time and are suited through the purchasers [5].

The use of fermented foods as a capability technique to fight sickness is developing, however it needs to be preferred that many of these practical meals are supposed to prevent disease onset, or alleviate signs, and now not necessarily act as a healing agent. This will increase the load of proof at the researcher to prove that the fermentation of the prebiotic became indeed the reason the host remained wholesome. Present study aims to develop fermented quinoa incorporated snack items to improve the quality of nutrients and microflora in the gut of human being to maintain digestibility and health.

Materials and Methods

Procurement of raw materials

Quinoa seeds were obtained from Department of Agronomy, College of Agriculture, PJTS Agricultural University, Rajendranagar, Hyderabad. The other ingredients were procured from local market of Hyderabad. The glassware and equipment were available at Post Graduate & Research Centre, PJTSAU, Rajendranagar, Hyderabad, were used throughout the study.

Processing of fermented quinoa flour

To prepare fermented quinoa flour wet milled quinoa flour fermented by fallowing the procedure of [6].

Preparation of traditional snack items

All the traditional snack items prepared by replacing major cereals and millet in the different proportions of 25%, 50%, 75%, 100% was given in the **Tables 1-3**. Snack item without incorporation of fermented quinoa flour was served as control. While preparing foxtail laddu jaggery was kept constant in guntapunugulu black gram dhal was kept constant. In murukulu rice flour was replaced by fermented quinoa flour. All the snack items were prepared fallowing the traditional procedures.

Table 1 ingredients used in preparations of foxtail laddu incorporated with fermented quinoa flour

Combinations	Foxtail (g)	Jaggery (g)	Fermented quinoa flour (g)
1	-	25	75
2	25	25	50
3	37.5	25	37.5
4	50	252	25
5	752	25	-

Table 2 Ingredients used in preparation of murukulu with fermented quinoa flour

Combinations	Rice flour (g)	Fermented quinoa flour (g)
1	-	100
2	25	75
3	50	50
4	75	251
5	100	-

Table 3 Ingredients used in preparation of guntapunugulu incorporated with fermented quinoa flour

Combinations	Rice (g)	Black gram dhal (g)	Fermented quinoa flour (g)
1	-	25	75
2	25	25	50
3	37.5	25	37.5
4	50	25	25
5	75	25	-

Sensory evaluation of products

Sensory evaluation of fermented quinoa based south Indian breakfast items were carried out by fifteen semi-trained panellists from PGRC, PJTSAU using 9 point hedonic scale [7], evaluated for attributes such as colour, texture, flavour, taste and overall acceptability. The scale were based on hedonic scale of 1 to 9 where: 1= I dislike extremely (very bad) and 9= I like extremely (excellent). The samples were presented with precoding of three digit numbers in individual booths in sensory evaluation lab. Panellist rinsed their mouth with water after testing each sample.

Statistical analysis

The results were statistically analysed [8] the results were presented as mean ± standard deviation. Difference between the variables was tested for significance by ANOVA using SAS version 9.1. To select final best acceptable combination of products the actual scores of overall acceptability given by 15 panel members were taken and box-plot diagram was drawn. Boxplot descriptive statistics are presented in Figures (2, 4 & 6) and discussed in the results.

Results and Discussion

Sensory acceptability of foxtail laddu

Mean sensory scores of fermented quinoa incorporated foxtail laddu were presented in **Figure 1**. The mean sensory scores of colour was ranged from 6.33±0.42 (QF2) to 7.20±0.24 (QF3). Colour score of QF3 was highest and was more than control laddu (6.67±0.23). Results showed that there was no significant difference ($p \leq 0.05$) between TCF and QF4, where as other have significant difference.

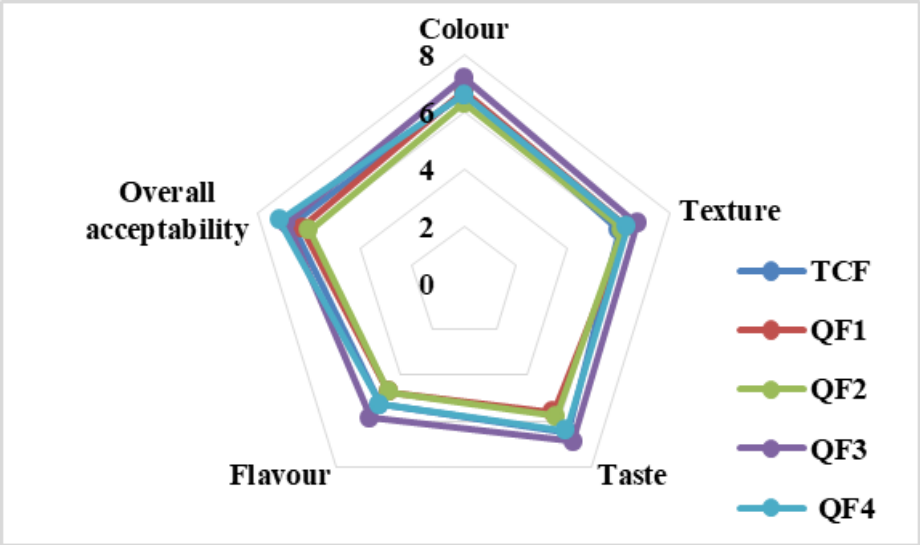

Figure 1 Mean sensory scores of foxtail laddu incorporated with fermented quinoa flour
TCF (Control) – Foxtail laddu prepared with foxtail and jaggery (75:25)
QF1 – Foxtail laddu prepared with fermented quinoa flour and jaggery (75:25)
QF2 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (50:25:25)
QF3 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (37.5:37.5:25)
QF4 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (25:50:25)

Highest mean sensory scores for texture was given to QF3 (6.73±0.34) whereas control TCF (6.00±0.54) got lowest score. Mean sensory scores for texture of foxtail laddu ranged from 6.73±0.34 to 6.00±0.54. There was no significant difference ($p \leq 0.05$) between QF1 and QF4 as well as TCF and QF2.

Taste and flavour of foxtail laddu was changed by increasing the addition of fermented quinoa flour. Mean sensory scores of foxtail laddu for taste and flavour QF3 got highest score than TCF. The highest mean sensory scores of QF3 for taste and flavour were 6.87±0.30 and 5.87±1.09 respectively (Figure 1). Compared to TCF and incorporated foxtail ladoo there was significant difference ($p \leq 0.05$) between them.

Overall acceptability of foxtail laddu QF4 (7.13± 0.29) had maximum mean sensory score than control (6.67±0.32) where as QF2 (6.00±0.44) was given minimum score. By increasing the incorporation of fermented quinoa flour to the foxtail laddu overall acceptability was decreased. Results showed that there was significant difference ($p \leq 0.05$) between TCF and incorporated foxtail laddu with fermented quinoa flour.

Similar results were reported by [5] in consumer acceptancy of multi grain ladoo by using 50 panellists. Results indicated that the mean scores of multigrain ladoo for different variables such as colour (8.32 ± 0.768), aroma (8.22 ± 0.864), taste (8.54 ± 0.646), texture (8.38 ± 0.753), appearance (8.32 ± 0.74), mouth feel (8.52 ± 0.735) and overall acceptability (8.68 ± 0.513) were significantly acceptable at 1% level. Multi grain ladoo had very good consumer acceptability.

To select final best acceptable combination of foxtail laddu the actual scores of overall acceptability given by 15 panel members were taken and box-plot diagram was drawn. Boxplot descriptive statistics are presented in **Figure 2**. The box plot diagram clearly shows that the median (8) and maximum (9) values of overall acceptability in the sample QF3 was slightly higher than control.

Sensory evaluation of murukulu incorporated with fermented quinoa flour

Mean sensory scores of murukulu was presented in **Figure 3**. The highest mean sensory scores of murukulu for colour were given to TCM (8.20±0.31) where as QM1 (5.67±0.58) was given lowest mean sensory score. The mean sensory score of murukulu for colour was decreased by increasing incorporation of fermented quinoa flour. Results indicated that there was significant difference ($p \leq 0.05$) between control (TCM) and murukulu incorporated with fermented quinoa flour.

Mean sensory scores of murukulu for texture, TCM (8.20±0.35) was given highest score than murukulu incorporated with fermented quinoa flour. Among the quinoa incorporated murukulu QM1(4.67±0.54) got lowest mean sensory score where as QM4 was given to highest (7.40±0.21). Results showed that there was significant difference ($p \leq 0.05$) between TCM and murukulu incorporated with fermented quinoa flour.

TCM was given highest mean sensory scores mean sensory scores of murukulu for taste (8.20±0.40), flavour (8.20±0.47) and overall acceptability (8.20±0.47) where as QM1 had lowest mean sensory score (Figure 3) Increasing

the incorporation of murukulu with fermented quinoa flour sensory attributes such as taste, flavour and overall acceptability were decreased within the fermented quinoa incorporated murukulu. QM4 was given highest score for taste (6.86±0.23), flavour (7.06±0.37) and overall acceptability (7.06± 0.43). Results showed that there was significant difference ($p \leq 0.05$) between TCM and murukulu incorporated with fermented quinoa flour.

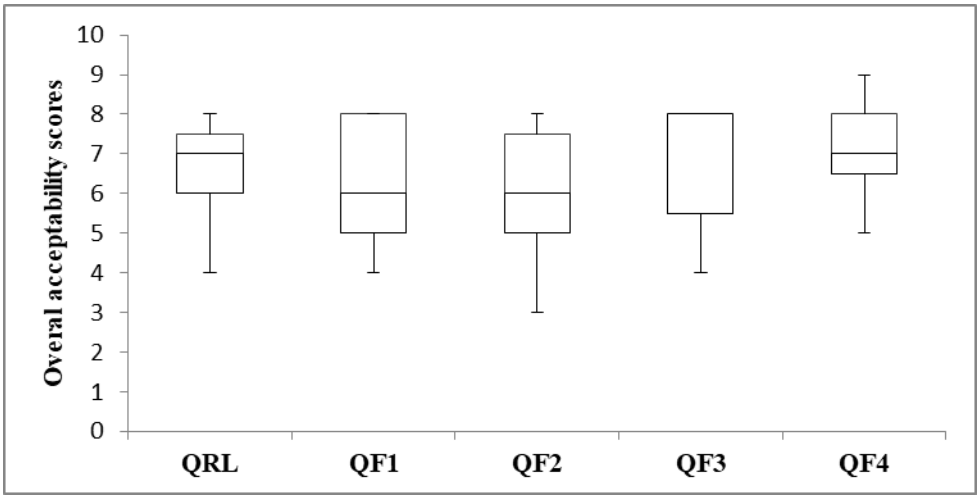

Figure 2 Box and whisker plots displaying median, inter quartile range (box) and range (whiskers) of overall acceptability of fermented quinoa incorporated foxtail laddu
TCF (Control) – Foxtail laddu prepared with foxtail and jaggery (75:25)
QF1 – Foxtail laddu prepared with fermented quinoa flour and jaggery (75:25)
QF2 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (50: 25:25)
QF3 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (37.5:37.5:25)
QF4 – Foxtail laddu prepared with fermented quinoa flour, foxtail and jaggery (25:50:25)

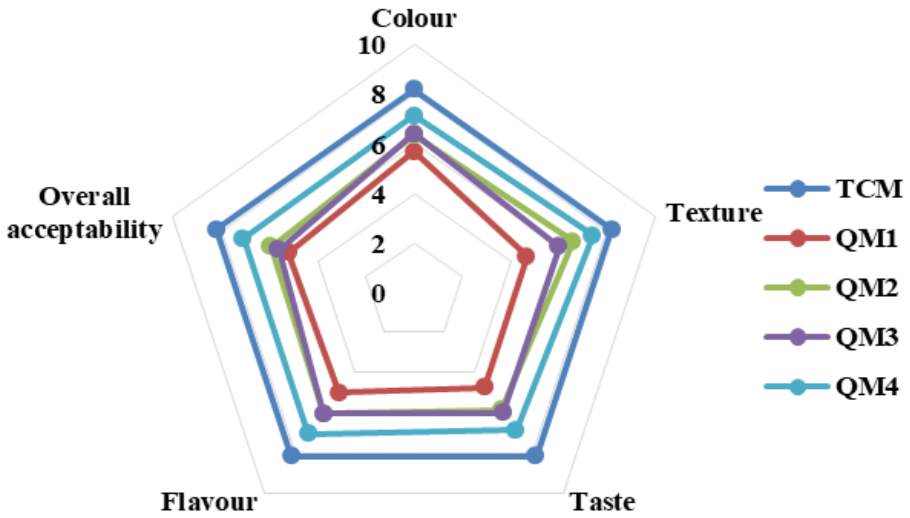

Figure 3 Mean sensory scores of murukulu incorporated with fermented quinoa flour
TCM (Control) – Murukulu prepared with rice flour only
QM1 – Murukulu prepared with fermented quinoa flour only
QM2 – Murukulu prepared with rice flour and fermented quinoa flour (25:75)
QM3 – Murukulu prepared with rice flour and fermented quinoa flour (50:50)
QM4 – Murukulu prepared with rice flour and fermented quinoa flour (75:250)

Similar results were reported by [4] in murukulu prepared with addition of finger millet malt at 40% and 60%. Acceptability of murukulu added with finger millet malt was dressed from 40% to 60%. Sensory acceptability scores were higher in standard than incorporated murukulu with finger millet malt.

To select final best acceptable combination of murukulu the actual scores of overall acceptability given by 15 panel members were taken and box-plot diagram was drawn. Boxplot descriptive statistics are presented in **Figure 4**.

The box plot diagram clearly shows that the median (9) and maximum (9) values of overall acceptability of QRL had highest value than all incorporated murukulu but QM4 had equal maximum value with control.

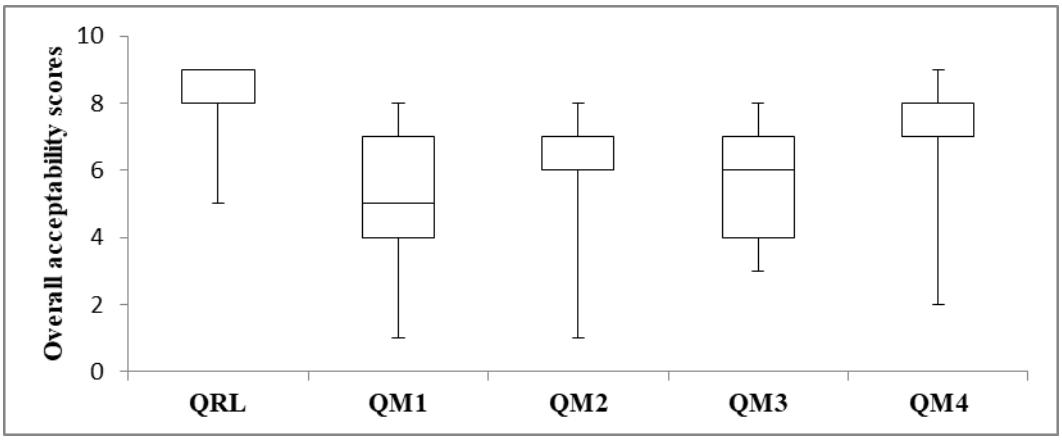

Figure 4 Box and whisker plots displaying median, inter quartile range (box) and range (whiskers) of overall acceptability of fermented quinoa incorporated murukulu
TCM (Control) – Murukulu prepared with rice flour only
QM1 – Murukulu prepared with fermented quinoa flour only
QM2 – Murukulu prepared with rice flour and fermented quinoa flour (25:75)
QM3 – Murukulu prepared with rice flour and fermented quinoa flour (50:50)
QM4 – Murukulu prepared with rice flour and fermented quinoa flour (75:25)

Sensory acceptability of guntapunugulu incorporated with fermented quinoa flour

Mean sensory scores of guntapunugulu are given in **Figure 5**. Control TCG (7.67±0.23) obtained highest score for colour compared with incorporated guntapunugulu QG4 (7.53±0.21), QG3 (7.27±0.25), QG2 (7.07±0.25) and QG1 (7.07±0.18). Results showed that there was no significant difference ($p \leq 0.05$) between QG1 and QG2 and also between QG3 and QG4. But there was significant difference ($p \leq 0.05$) between TCG and guntapunugulu incorporated with fermented quinoa flour.

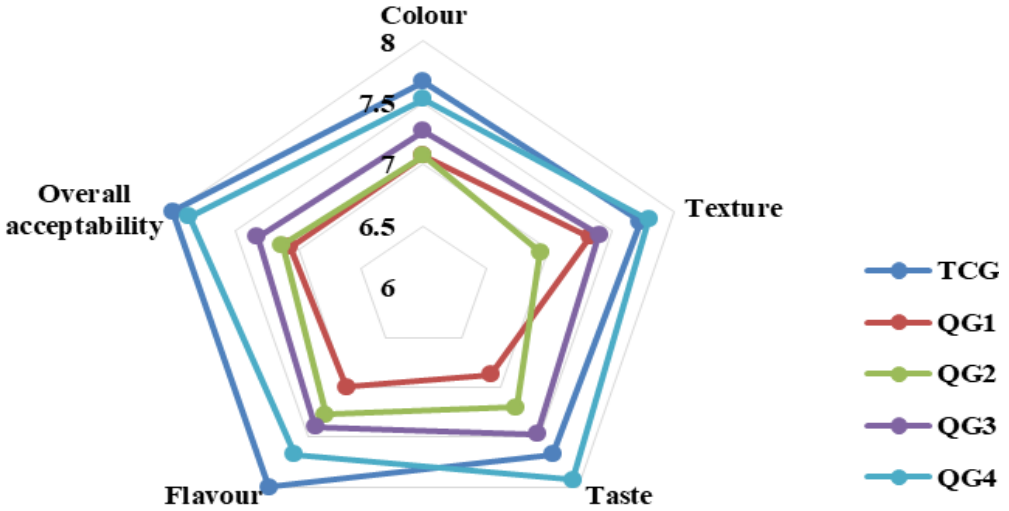

Figure 5 Mean sensory scores of guntapunugulu incorporated with fermented quinoa flour

TCG (Control) – Guntapunugulu prepared with rice and black gram dal (75:25)
QG1 – Guntapunugulu prepared with black gram dhal and fermented quinoa flour (25:75)
QG2 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (25:25:50)
QG3 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (37.5:25:37.5)
QG4 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (50:25:25)

In the incorporated guntapunugulu QG4 (7.80±0.22) was given highest score for texture than control QGC where as QG2 (6.93±0.15) obtained lowest mean sensory score. Increasing order of mean sensory scores of guntapunugulu for texture as fallows QG2(6.93±0.15) <QG1 (7.33±0.30) <QG3 (7.40±0.25) <CRL (7.73±0.30) <QG4 (7.80±0.22).

results showed that there was no significant difference at p≤0.05 between QG1 and QG3 and also between TCG and QG4.

Mean sensory scores of guntapunugulu for taste, QG4 (7.93±0.18) got highest score than TCG (7.67± 0.30). The mean sensory scores of guntapunugulu was ranged from 7.93±0.18 to 6.87±0.27. Results showed that for increasing the addition of fermented quinoa flour to the guntapunugulu taste was decreased. Results showed that that there was no significant difference (p≤0.05) between QG4 and TCG.

Mean sensory scores for flavour of guntapunugulu incorporated with fermented quinoa flour were decreased because of increasing the incorporation of fermented quinoa flour. Compared to control with incorporated samples, TCG (8.00± 0.26) had highest score where as QG1 (7.00±0.28) had lowest score. The increasing order of mean sensory scores were QG1 (7.00±0.28) < QG2 (7.27±0.23) < QG3 (7.40±0.30) <QG4 (7.67±0.21) < TCG (8.00± 0.26) (Figure 5). Results showed that the mean sensory scores of guntapunugulu for flavour had no significant difference (p≤0.05) between QG1 and QG2 and QG3 and QG4. Compared to the control and guntapunugulu incorporated with fermented quinoa flour there was significant difference (p≤0.05).

Overall acceptability of guntapunugulu prepared with TCG (8.00± 0.19) had highest score compared with the incorporated guntapunugulu and QG1 (7.07±0.25) had lowest mean sensory score. Overall acceptability of fermented quinoa flour incorporated guntapunugulu had decreased by increasing the addition of fermented quinoa flour. Results were showed that there was significant difference (p≤0.05) between TCG and guntapunugulu incorporated with fermented quinoa flour.

Figure 6 shows the boxplot descriptive statistics of actual scores of overall acceptability given by 15 panel members for fermented quinoa incorporated guntapunugulu. The box plot diagram clearly shows that the median (8) and maximum (9) values of overall acceptability in the sample QG4 are equal to control (TCG) sample (uniform shaped histogram) indicates data that is very consistent; the frequency of experimental class is very similar to that of the control.

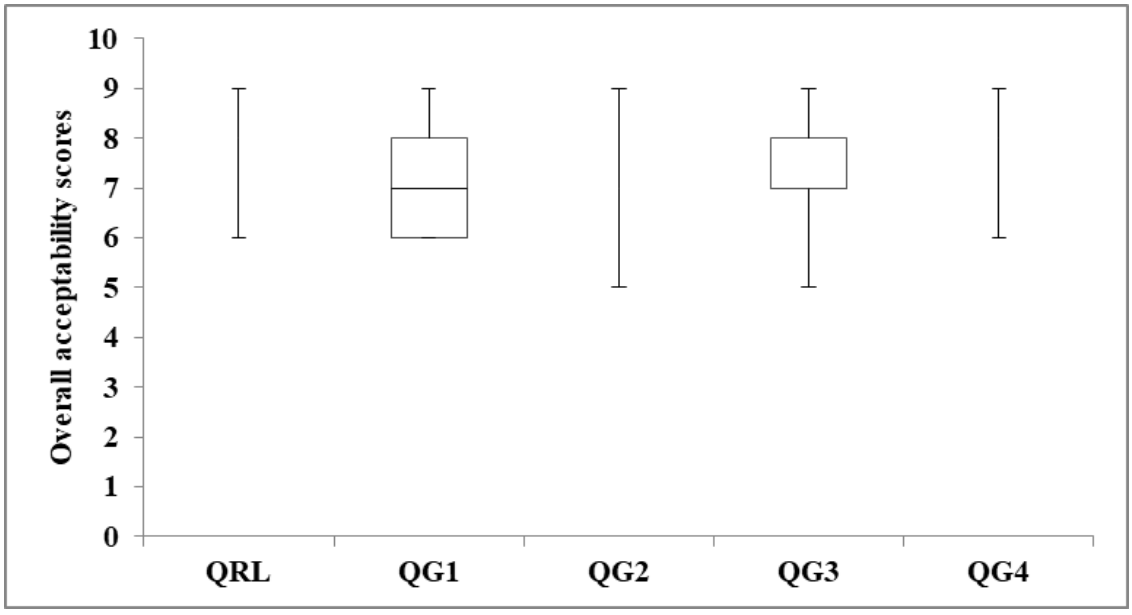

Figure 6 Box and whisker plots displaying median, inter quartile range (box) and range (whiskers) of overall acceptability of fermented quinoa incorporated guntapunugulu

TCG (Control) – Guntapunugulu prepared with rice and black gram dal (75:25)
QG1 – Guntapunugulu prepared with black gram dhal fermented quinoa flour (25:75)
QG2 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (25:25:50)
QG3 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (37.5:25:37.5)
QG4 – Guntapunugulu prepared with rice, black gram dhal and fermented quinoa flour (50:25:25)

Plate 1 Preparation of foxtail laddu incorporated with fermented quinoa flour

Plate 2 Preparation of murukulu incorporated with fermented quinoa flour

Plate 3 Preparation of guntapunugulu incorporated with fermented quinoa flour

Conclusion

Quinoa is excellent nutritious grain but digestibility was low because of antinutrients. Traditional food processing technique like fermentation was used to improve the digestibility, nutrient content and enhance the flavour of products their by decreasing the antinutritional factors. So that fermentation process was carried out to increase the acceptability of quinoa through traditional snack items. Present study revealed that acceptability of snack items such as foxtail laddu, murukulu and guntapunugulu were organoleptically like moderately.

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