

RESEARCH ARTICLE

Quality characteristics of green gram blended instant sorghum porridge prepared from fermented and germinated grains

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Abstract: The present study aimed to develop nutritionally rich green gram blended sorghum porridge and evaluate the nutritional and organoleptic characteristics of the developed product. The raw, fermented, and germinated sorghum and green gram were dried and milled and the obtained grits were evaluated for nutritional parameters. The crude protein, phosphorus, and acidity significantly ($p < 0.05$) increased in sorghum, while ash and carbohydrate content decreased ($p < 0.05$) in both sorghum and green gram after fermentation and germination. Control, fermented grits, and germinated grains porridges were analyzed for organoleptic characteristics after reconstitution with water and 12% sugar. The fermented sorghum porridge with 20% fermented green gram received a significantly ($p < 0.05$) higher acceptability score whilst germinated green gram could be blended up to 35% in germinated sorghum to obtain the highest sensorial scores. Using the best organoleptically accepted porridges when reconstituted with water, milk was used to reconstitute the porridges for further organoleptic characteristics analysis. The fermented blended sorghum porridge received significantly ($p < 0.05$) highest acceptability scores, followed by germinated green gram sorghum porridge.

Key words: sorghum, green gram, fermented, germinated, reconstitution, nutritional composition

Introduction

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Porridge is a popular grain-paste breakfast meal prepared primarily from whole or crushed cereal grains. Grains like rice, wheat, oat, maize, or sorghum are commonly used to prepare porridge. To get the desired consistency, the product is prepared by boiling whole, ground, crushed, or chopped grains in water or milk. Further, the grains can be either used as such (untreated grains) or fermented/germinated. Cooked porridge can be converted into a sweet cereal by adding sugar, honey, fruit, or syrup, or it can be made into a savory meal by adding salt and spices. Whole grain porridge is a good aid for diabetes patients because of its high level of dietary fiber and fructans. The high fiber content in whole-grain porridge helps with stool thickening and fullness, prevents coronary heart disease development, and regulates other physiological processes (Alahmari, 2024). Porridge nutrition is regulated by grain processing characteristics such as fermentation, germination, mixing, and heating. Porridge is a traditional and simple way to ingest grains like sorghum since it requires minimal processing, thus maintaining most of the nutritious value for users.

Among various grains, sorghum (*Sorghum bicolor*) is a hard-cereal grain that may be processed into various food products. It is the world's fifth most significant cereal. It's a low-fat, high-fiber grain and a good source of macro minerals, phosphorus, magnesium, potassium, and iron. The product prepared from sorghum does not impart colour, offers a neutral taste, or flavor, after consumption. Further, because of the current growth in celiac illness, this cereal can be used to substitute gluten-containing cereals such as wheat (Oghbaei and Prakash 2016).

The porridge prepared from sorghum is a staple cuisine in Africa, where it is primarily used as a supplement and weaning food for newborns (Adebo, 2020), and as dietary supplements for patients and elderly people. Sorghum can also be used to prepare fermented porridge that is sweetened and eaten by both newborns and children in tropical areas. Cereals generally lack lysine and tryptophan, but the germination of grains can be used to boost the lysine level. Further, in producing porridge, combining grains and legumes boosts the nutritious content and improves the protein quality. Supplementing cereal-based porridge with high-lysine meals like pulses further helps to

increase the digestibility of the product (Oghbaei and Prakash 2016).

Green gram (*Vigna radiata*), a legume that grows largely in tropical and subtropical climates, has a high lysine concentration. It is consumed as a whole, split, or in germinated form. It contains approx. 60% carbs, a small amount of fat, and high in fiber. The principal minerals present in green grams are calcium, phosphorus, iron, sodium, and potassium (Diatta et al. 2024).

Cereals and legumes are rich in macronutrients and micronutrients. Further, phytochemicals and anti-nutritional compounds are also present that obstruct the nutrient bioavailability by binding with the existing nutrients. Fermentation and germination of both cereals and legumes can disrupt these binding, by the activity of the enzymes that break down anti-nutritional components and break complicated macronutrients into simple ones and make them easy to digest (Nkhata et al. 2018). Keeping the above facts in view, the present study aimed to develop nutritionally rich sorghum-green gram-based porridge using fermentation and germination.

Materials and methods

Sorghum variety (HJ-541) and green gram variety (MH-421) used in the present study were procured from the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. Sugar and double-toned milk of the brand Amul were procured from the local market. Pure culture of *Lactobacillus casei* used for fermentation was procured from the Institute of Microbial Technology, Chandigarh, India. The culture was then maintained on slants and subcultured after every 30 days. All experiments were conducted in triplicates with analytical grade chemicals from CDH, Sigma-Aldrich, and Himedia.

Treatments of whole-grain grains, milling, and instantisation

The control sorghum porridge was prepared by pressure-cooking grits for 30 min with grains: water ratio, 1:1, followed by tray drying. Fermented porridge was prepared by inoculating a loop full of *Lactobacillus casei* (2%) culture in sorghum and green gram grits slurries (grits: water ratio 1:1) which were incubated at $37 \pm 2^\circ\text{C}$ for 48 hours and stopped by cooking. To obtain germinated grains, sorghum and green gram grains were hydrated by soaking in distilled water (grain: water ratio 1:5) then thinly spread on a wet jute bag and kept in the dark to germinate for 48 hours followed by cooking. The details of the preparation of green gram sorghum porridge are mentioned in fig. 1. About 50 g of the instant sorghum porridges ISP *i.e.*, control instant sorghum porridges CISP, fermented instant sorghum porridges FISP, and germinated instant sorghum porridge GISP were analyzed for various physicochemical and organoleptic analyses.

Estimation of proximate composition

The sample's moisture, crude protein, crude fat, crude fiber, and ash content were evaluated according to the AOAC method (2016). The difference method was used to calculate carbohydrate content. The energy was determined using the following formula:

$$\text{Energy (kcal/100g)} = 4.0 \times \text{Protein (\%)} + 4.0 \times \text{Carbohydrates (\%)} + 9.0 \times \text{Fat (\%)}$$

Estimation of acidity and pH

5 gm porridge sample was diluted with 50 ml distilled water and the pH of the sample were analysed using a pH meter (Systronics). The percent acidity of samples was estimated after dilution using the method given by AOAC (2016).

Estimation of mineral

The determination of phosphorus was carried out by the Vanadomolybdophosphoric yellow color method (Koenig and Johnson 1942). The method of Chopra and Kanwar (1990) was employed to determine the calcium and magnesium content. Available iron in the sample was extracted and estimated according to the procedure of Rao and Prabhavathi (1978).

Sensory evaluation

Various blends of (fermented and germinated grain) instant porridges (IPs) were reconstituted in boiling water (Instant Sorghum Porridge: water 1:5 w/v) and cooked for 5-7 minutes with continuous stirring on a slow flame before presenting for sensory evaluation. Sugar @ 12% initially standardized in the preliminary studies, was added during preparation. Similarly, the best combination of fermented and germinated grain instant porridge was reconstituted in boiling milk (Instant Sorghum Porridge: water 1:5 w/v) and cooked for 5-7 minutes with intermittent stirring. A panel of ten trained panellists carried out the sensory evaluation of hot-cooked porridge. The porridge was evaluated for colour and appearance, aroma, taste and consistency using a 9-point Hedonic scale as described by Ranganna (1986). Color and appearance (the visual appeal, presence of burnt particles, browning, or a dull appearance), flavour (sensory acidity and foreign flavours), texture (creaminess, mouthfeel, richness, and viscous behaviour on the palate and tongue), and overall acceptability were evaluated.

Statistical analysis

Data were analyzed using analysis of variance (ANOVA), using OP Stat, Statistical analysis software developed by the Department of Mathematics and Statistics, CCS, HAU Hisar. The critical difference (CD) at a 5% level was used to compare different treatments. The results are expressed as a mean of three replications.

Results and Discussion

Physico-chemical properties of raw and treated sorghum and green gram grains

Proximate analysis

Fermentation and germination of grains affect their proximate composition, affecting the final product quality. Raw, fermented,

and germinated sorghum and green gram grains were evaluated for proximate composition to determine the effect of different treatments on the nutritional composition of the grains (Table 1).

Fermented sorghum showed significantly ($p \leq 0.05$) higher moisture content (9.02 %), while the moisture content was comparable in raw and germinated sorghum. However, germinated green gram had significantly ($p < 0.05$) higher moisture content (14.75 %) followed by fermented green grams. Shah et al. (2011); Khalil et al. (2007) observed an increase in the moisture content

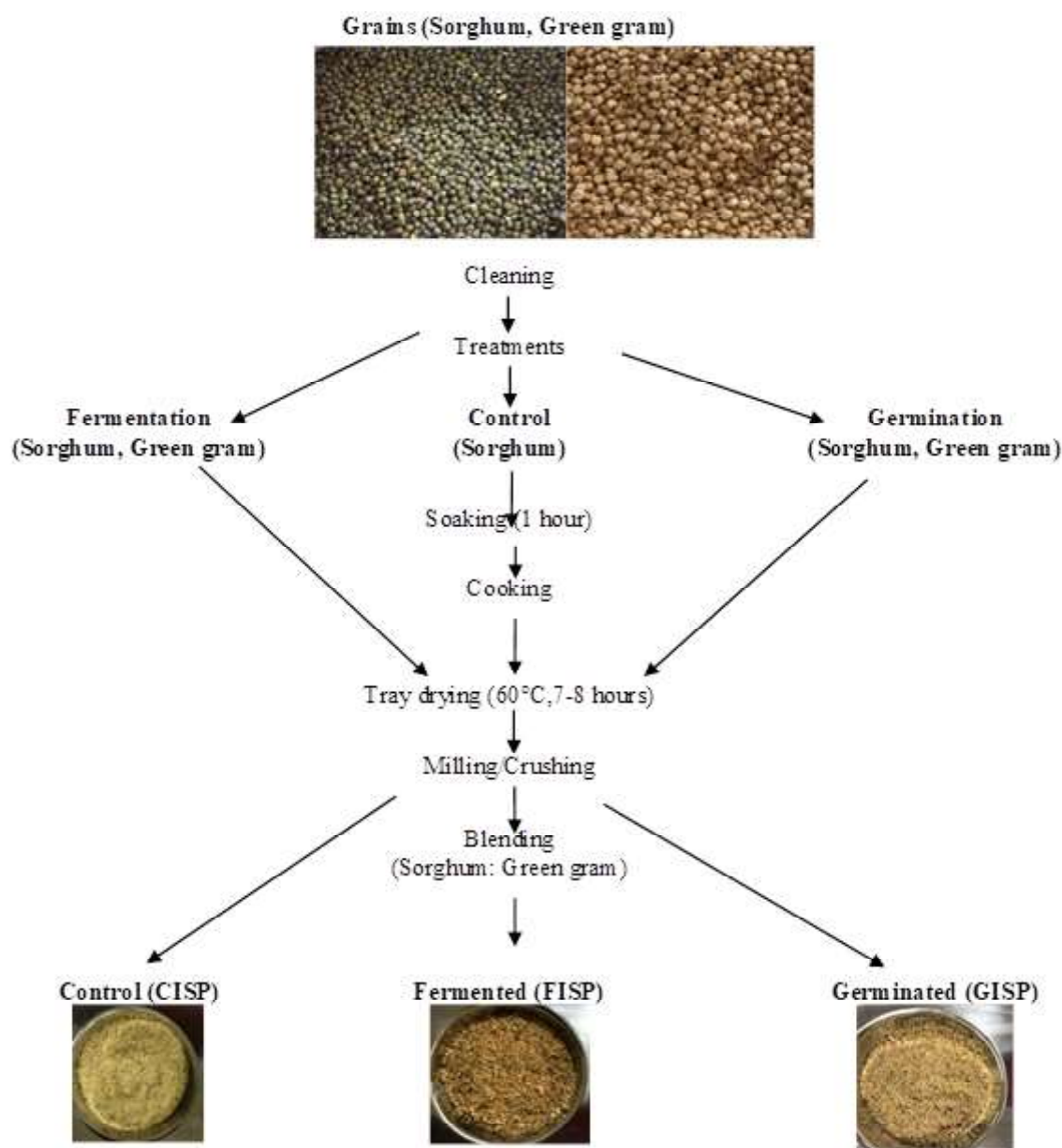


Fig. 1: Flow diagram for the development of green-gram blended instant sorghum porridge

after germination of chickpea, hence agreeing with the results obtained in the present study. Nonogaki et al. (2010) explained that the number of hydrated cells is a determining factor for the gained moisture after either fermentation or germination. Further, moisture content of developed product is directly dependent on the fermentation and germination duration. (Massod et al. 2014).

Fermentation and germination of sorghum grains resulted in a non-significant difference in crude fat content from raw sorghum grains, ranging from 1.39 to 1.55%. However, crude fat content was significantly ($p < 0.05$) higher in raw green grams. On the other hand, fermented and germinated green grams had comparable fat content. The decrement in the fat content in fermented grains was because of the action of lactic acid bacteria using the fats for energy. During germination, the respiration process also requires energy derived from the fats. The results obtained agree with Adam et al. (2013), who studied the effect of fermentation on the nutritional composition of five different sorghum varieties. Adebo (2020) also shares similar results. Afify et al. (2012) studied three varieties of sorghum before and after

germination, and the crude fat content decreased after germination. Warle et al. (2015) determined germination's effect on sorghum's nutritional quality, and a similar decrease in crude fat was observed. Oghbaei and Prakash (2016) observed that fermentation and germination processes decrease the crude fat content of green grams.

Germinated sorghum had significantly ($p < 0.05$) higher crude protein content (10.91%) than fermented (10.50%) and raw (9.30%) grains. However, no significant difference was observed in raw and germinated green gram grains. Fermented green gram ($p < 0.05$) grains had a significantly higher crude protein content of 22.30%. Bhathal and Kaur (2015) reported that the decrease of carbohydrates and crude fat led to increased proteins after fermentation and germination. The fermentation process increases protein content due to decreased dry matter as carbohydrates and fats are used for energy by microorganisms. Microbial fermentation increases the protein content, and lysine is produced during fermentation, thereby raising the protein level (Zhang et al. 2015).

Table 1: Proximate composition of raw, fermented and germinated sorghum and green gram –grains

Parameters	Sorghum			Green gram		
	Raw	Fermented	Germinated	Raw	Fermented	Germinated
Moisture (%)	8.66±0.47 ^a	9.02±1.03 ^b	8.80±0.81 ^a	10.22±1.47 ^x	11.27±1.01 ^y	14.75±0.61 ^z
Crude fat (%)	1.55±0.41 ^{ns}	1.42±0.49 ^{ns}	1.39±0.38 ^{ns}	2.45±0.40 ^y	1.78±0.21 ^x	1.74±0.28 ^x
Crude protein (%)	9.30±1.04 ^a	10.50±1.34 ^b	10.91±0.31 ^c	15.25±0.10 ^x	22.30±1.28 ^y	16.15±2.05 ^x
Crude fibre (%)	2.27±0.41 ^b	1.51±0.30 ^a	1.99±0.66 ^b	3.34±0.56 ^y	1.42±0.03 ^x	2.44±0.15 ^{xy}
Ash (%)	3.44±0.37 ^c	2.56±0.31 ^b	1.77±0.71 ^a	8.16±0.22 ^z	5.02±0.27 ^x	6.60±0.66 ^y
Carbohydrates (%)	71.78±1.26 ^c	69.12±1.74 ^a	70.63±1.23 ^b	64.33±0.71 ^z	60.11±0.78 ^x	61.60±0.62 ^y
Energy (kcal)	352.70±0.72 ^c	334.49±1.51 ^a	342.55±1.02 ^b	340.37±1.64 ^z	313.43±0.33 ^x	325.12±0.43 ^y

Values are mean ± SD of three replicates

Means within rows with different superscripts, are significantly different ($p < 0.05$) from each other

ns= non-significant

Table 2: Mineral composition of raw, fermented and germinated sorghum and green gram grains

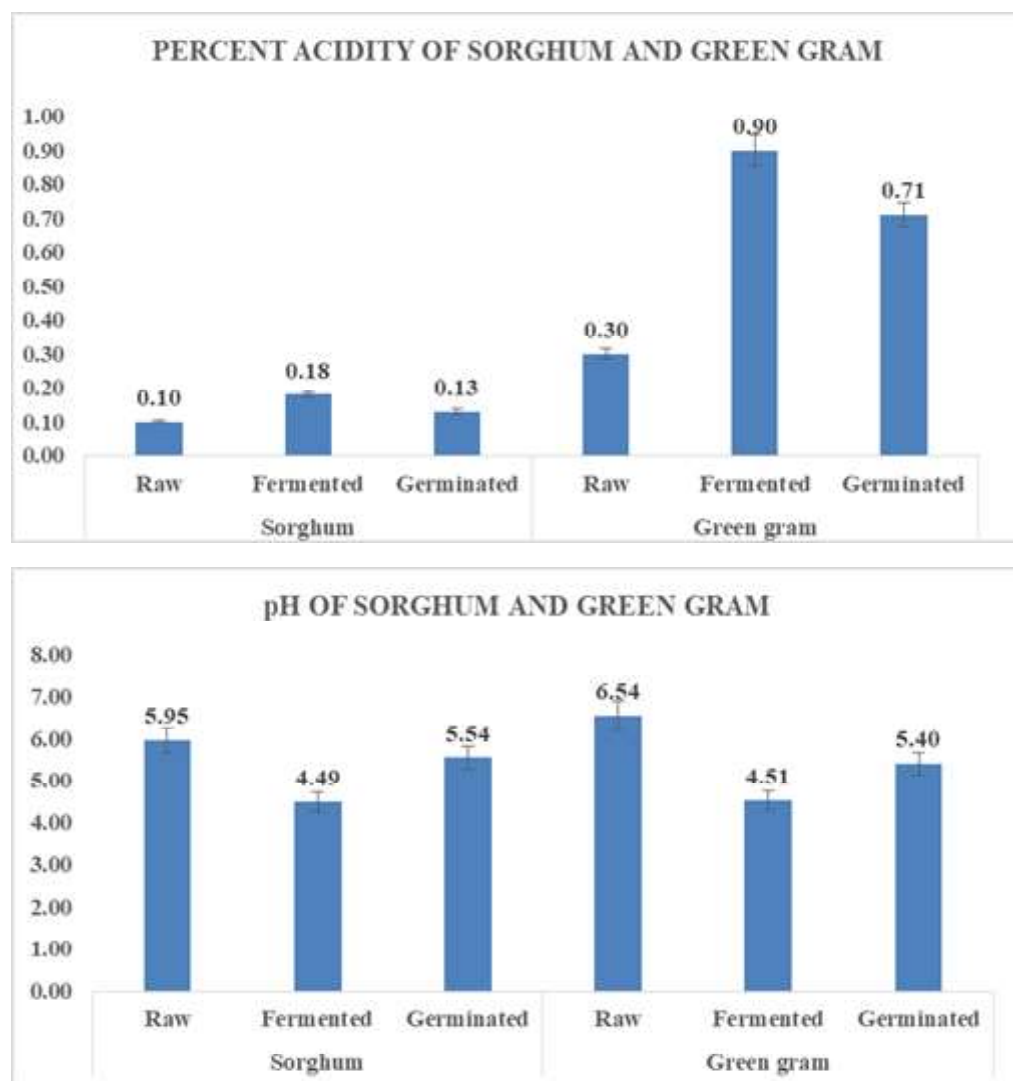
Parameters	Sorghum			Green gram		
	Raw	Fermented	Germinated	Raw	Fermented	Germinated
Phosphorus (mg/100g)	363.84±2.28 ^a	473.65±1.43 ^b	481.45±1.32 ^c	214.27±0.44 ^x	217.99±0.38 ^z	216.45±0.35 ^y
Magnesium (mg/100g)	250.16±0.49 ^c	223.21±0.30 ^a	246.38±0.34 ^b	132.22±0.58 ^x	134.21±1.40 ^x	133.20±1.53 ^x
Calcium (mg/100g)	198.55±2.21 ^c	157.38±0.30 ^a	164.44±0.17 ^b	203.23±0.46 ^x	210.36±1.51 ^y	216.40±1.83 ^z
Iron (mg/100g)	13.50±2.12 ^c	13.00±1.41 ^b	11.40±0.14 ^a	18.28±1.32 ^x	20.71±0.74 ^z	19.27±0.39 ^y

Values are mean ± SD of three replicates

Means within rows with different superscripts are significantly different ($p < 0.05$) from each other

Fig. 2: Percent Acidity and pH of control, fermented and germinated Sorghum and green gram

a) Acidity b) pH



Fermentation of sorghum grains indicated a significant ($p < 0.05$) decrease in the dietary fiber content to 1.51% from 2.27% of sorghum grains. However, there was no significant difference between raw and germinated grains. Similarly, fermented green gram showed a significantly ($p < 0.05$) lower crude fiber content of 1.42% while germinated grains were neither significantly different from raw nor fermented grains. Determination of crude fiber measures the indigestible cellulose; lignin as well as other components found in the specific food, it also evaluates the milling efficiency to separate endosperm and bran (Fahey, 2019).

Ash content decreased significantly ($p < 0.05$) from 3.44% in raw sorghum grains after fermentation to 2.56% and germination to 1.77%. Accordingly, the same trend of significant ($p < 0.05$) decrease of ash content was observed after fermentation and germination of green gram grains. Warle et al. (2015) also indicated that ash content decreased due to a decrease in mineral content.

Carbohydrates (%) and Energy (kcal): Carbohydrates and energy significantly ($p < 0.05$) decreased in fermented and germinated sorghum grains. Fermentation of grains showed a higher decrease in both sorghum and green gram grains. The glucose released during fermentation is a preferred substrate for microorganisms fermenting the food and could partly explain the decrease in total carbohydrates after 24 hr of fermentation. The sorghum grains results obtained are similar to those reported by Adebo (2020), Afify et al. (2012) and Warle et al. (2015). Carbohydrates are used for respiration during germination hence the decrement of carbohydrates content and energy consequently (Bhathal and Kaur 2015). Germination conditions allow enzymatic hydrolysis of starch to simple sugars leading to a decrement of carbohydrates after grain germination (Oghbaei and Prakash 2016).

Mineral composition

As depicted from Table 2, fermented and germinated sorghum grains indicated significantly ($p < 0.05$) higher phosphorus content

than raw grains, however Mg, Ca and Fe content were significantly ($p < 0.05$) low in grain. Green gram showed no significant ($p < 0.05$) difference in Mg content of raw, fermented, and germinated lentils whilst Ca and Fe content were significantly ($p < 0.05$) higher after fermentation and germination. A study by Makokha et al. (2002) agrees that fermentation and germination of Kenyan varieties of sorghum grains increased mineral content with a higher increase in germinated grains. An effect of germination on the mineral content of horse gram and green gram malt was determined by Sadawarte et al. (2018), germination was found to decrease phosphorus, magnesium, calcium, and iron from 321.68 to 256, 184 to 136.5, 70.86 to 11.6 and 5.6 to 4.03 mg/100g simultaneously. Cereals and legumes contain minerals that are complexed with non-digestible materials like polysaccharides and phytate making their bioavailability low. Fermentation and germination free the complexed minerals in the grains (Oghbaei and Prakash 2016).

The phytase enzyme contained in legumes and cereals is activated during germination leading to the destruction of phytate for the release of bound minerals. Mineral content, therefore, is increased post-fermentation and germination (Ogbonna et al. 2012).

Acidity and pH of Sorghum and green gram

Acidity of sorghum grains significantly ($p < 0.05$) increased after fermentation from an initial 0.10 % to 0.18 % and to 0.13 % after germination (Fig. 2a). pH decreased after both fermentation and germination (Fig. 2b). Green gram grain similarly showed a significant ($p < 0.05$) increase in acidity and decrease in pH. Jood et al. (2012) studied the effect of germination and probiotic fermentation on pH and titratable acidity of sorghum-based food mixtures, the pH was 6.23 and the titratable acidity was 1.71 g lactic

Table 3: Effects of fermentation and germination on sensory characteristics of water reconstituted* instant sorghum porridges

Porridge (Sorghum:GG)	Colour & Appearance	Texture	Taste	Flavour	Overall acceptability
Fermented sorghum porridge (incorporated with green gram)					
Control (T ₀)	7.93±0.43 ^{cd}	7.98±0.27 ^a	7.80±0.76 ^a	6.60±0.55 ^b	7.69±0.75 ^a
100:0 (T ₁)	8.00±0.79 ^d	8.00±0.33 ^a	8.31±0.53 ^c	6.51±0.44 ^b	7.65±0.66 ^b
80:20 (T ₂)	7.56±0.32 ^c	8.38±0.27 ^b	8.56±0.33 ^c	7.31±0.79 ^d	7.88±0.78 ^b
75:25 (T ₃)	7.00±0.33 ^b	8.50±0.41 ^{bc}	7.74±0.62 ^b	6.97±0.63 ^c	6.75±0.34 ^a
70:30 (T ₄)	6.79±0.54 ^{ab}	8.66±0.11 ^{bc}	7.51±0.22 ^a	6.91±0.42 ^c	6.62±0.66 ^a
65:35 (T ₅)	6.51±0.22 ^a	8.77±0.29 ^c	7.33±0.29 ^a	6.24±0.34 ^a	6.38±0.21 ^a
Germinated sorghum porridge (incorporated with green gram)					
Control (T ₀)	8.03±0.43 ^a	7.98±0.27 ^b	7.80±0.76 ^a	6.90±0.55 ^a	7.69±0.75 ^a
100: 0 (T ₆)	8.51±0.33 ^b	6.91±0.76 ^a	7.32±0.42 ^a	7.68±0.38 ^a	7.03±0.55 ^a
80: 20 (T ₇)	7.50±0.61 ^a	7.01±0.32 ^a	7.51±0.22 ^a	7.81±0.33 ^a	7.24±0.33 ^a
75: 25 (T ₈)	7.38±0.82 ^a	7.88±0.43 ^a	7.54±0.24 ^a	8.43±0.67 ^b	7.48±0.77 ^a
70: 30 (T ₉)	7.30±0.22 ^a	7.95±0.91 ^b	7.67±0.38 ^b	8.64±0.66 ^b	7.56±0.92 ^a
65:35 (T ₁₀)	7.20±0.91 ^a	8.32±0.36 ^c	8.78±0.11 ^c	8.75±0.43 ^b	8.26±0.33 ^b

Values are mean ± SD of three replicates

Means within columns with different superscripts, are significantly different ($p < 0.05$) from each other

*After reconstitution (ISP: Water = 1:5)

Table 4: Effects of fermentation and germination on sensory characteristics of milk reconstituted* instant sorghum porridges

Instant Sorghum Porridge	Colour & Appearance	Texture	Taste	Flavour	Overall acceptability
Control	8.10±0.45 ^a	7.96±0.27 ^b	7.88±0.25 ^a	6.99±0.58 ^a	7.69±0.20 ^a
Fermented 80:20 (T ₂)	8.49±0.55 ^b	8.10±0.33 ^b	8.58±0.45 ^b	7.08±0.35 ^a	8.08±0.25 ^b
Germinated 65:35 (T ₁₀)	7.96±0.32 ^a	6.53±0.77 ^a	8.10±0.36 ^b	8.20±0.41 ^b	7.78±0.30 ^a

Values are mean ± SD of three replicates

Means within columns with different superscripts, are significantly different ($p < 0.05$) from each other

*After reconstitution (ISP: milk = 1:5)

acid/ml. Onwurafor et al. (2014) studied the effect of fermentation methods on chemical and microbial properties of green gram (*Vigna radiata*) flour; an increase in acidity from 0.009 % to 0.011 % and decrease in pH from 6.24 to 3.68 simultaneously was reported. The fermentation process leads to decreased pH and increased acidity because of lactic acid accumulated due to microbial activity. Lowered pH inhibits the growth of spoilage microbes in grains resulting in high storage quality. Fermentation of legumes resulted in lower pH values because their high protein content buffers acids involved in the process (Nkhata et al. 2018).

Effects of fermentation and germination on sensory scores of water reconstituted Instant sorghum porridge (ISPs)

Fermentation and germination of sorghum and green gram were done to add value to sorghum porridge and instantization provides convenience by reduction of cooking time. Table 3 shows the effect of fermented and germinated instant sorghum porridges on the sensory scores after reconstitution.

Appearance is an important factor in food. Fermented sorghum porridge (T_1) and germinated sorghum porridge (T_6) had colour & appearance scores of 8.00 and 8.51 respectively. Results obtained by (Onweluzo and Nnamuchi (2009) on a study of sorghum porridge agree with the present findings depicting that sorghum fermented for 48 hours had significantly ($p<0.05$) higher colour and appearance score. Fermentation and germination reduce the tannins thereby lightening cereals. The longer the process, the lighter the cereals become (Olamiti et al. 2020). The addition of green gram significantly ($p<0.05$) decreased the colour & appearance scores of both fermented sorghum porridge and germinated sorghum porridge since green gram is darker in appearance than sorghum and judges preferred lighter colour and appearance in the porridges. Adebo et al. (2020) indicated in the sensory evaluation of sorghum porridge that the dark brown colour in porridge is unattractive. The texture score of fermented sorghum porridge was significantly ($p<0.05$) lower in T_1 whilst in germinated porridges (T_6 , T_7 , and T_8) the scores were not significantly different. Osungbaro (1990) contradicts the texture sensorial results associated with fermented maize porridge as in their study, the fermentation process improved the textural characteristics in terms of consistency, gelling tendency, and starch stability. It is probable that different cereal grains behave differently due to their distinct kernel structure. Fermented sorghum porridge taste score was significantly ($p<0.05$) higher in T_1 (8.31) and T_2 (8.56) whereas in germinated sorghum (T_{10}) it was 8.78. Despite Osungbaro (1990) indicating that fermented porridge can have low taste and flavour scores due to high acids and other flavors development, it can be argued that the period of fermentation process may also have an impact on these sensory scores. Taste of fermented sorghum porridge decreased with higher green gram proportion whilst germinated sorghum porridge taste increased with higher green gram proportion; this maybe because of the undesirable smell and taste from fermented green

gram. Fermented sorghum porridges had the flavour scores ranging from 6.24 to 7.31 whereas in germinated porridge the range was from 7.68 to 8.75. As mentioned above, the undesirable flavour of fermented green gram led to lower sensory scores hence the scores reduced as the fermented green gram proportion increased. Overall acceptability of fermented sorghum porridge was not significantly ($p<0.05$) different between T_1 (7.65) and T_2 (7.88) while GISP (T_{10}) with 8.26 overall acceptability scores being the most preferred sorghum porridge. Porridge made from germinated grains was found to be more acceptable overall with the increased green gram proportion having a high overall acceptability score. This is due to the flavonoids activated in green gram during the germination process. It is the opposite for fermented green gram which produces an undesirable flavour and taste. Subsequently increased proportion of fermented green gram improved porridge texture.

Effects of fermentation and germination on sensory scores of milk reconstituted Instant sorghum porridge (ISPs)

To determine the effect of fermentation and germination on sensory scores of milk reconstituted instant sorghum porridges, T_2 and T_{10} were used since they had the best overall acceptability according to Table 4. It was observed that colour and appearance score was significantly ($p<0.05$) higher in T_2 whilst T_{10} and control were not significantly ($p<0.05$) different. Evidently, the light colour in fermented porridge gave attractive appearance hence the best sensory score in this accord. Germination process led to a development of sprouts which contains radicles in their structure. Since these radicles were not removed during processing, they probably gave an unattractive appearance in the porridge hence the low colour & appearance and textural scores were obtained. T_{10} obtained a significantly ($p<0.05$) lower textural score for the reason mentioned above as the dried rootlets present were felt in the in mouth during sensory evaluation of porridge. Taste scores were significantly ($p<0.05$) higher in fermented porridge (8.58) and germinated porridge (8.10) as compared to control (7.88). Processes of fermentation and germination improved taste in the porridges. Because taste plays a significant role in food selection and consumption, a developed food product with high sensory taste ratings is likely to be well-received and palatable. Hutkins (2006) indicated that fermented foods are highly valued because of rich and complex taste and odour. It can be argued that fermentation generates flavour. The results on the other hand displayed no significant ($p<0.05$) difference between control (6.99) and fermented (7.08) porridges. T_{10} on the other hand had a significantly ($p<0.05$) higher flavour score of 8.20 and this might be due to the reactions occurring during germination that activate the flavour components to release desirable flavours in green gram grains. Overall acceptability score of 8.08 of T_2 was not significantly ($p<0.05$) different from that of T_{10} (7.78). Even though T_2 overall acceptability (8.08) was significantly ($p<0.05$) higher than control porridge (7.69), T_{10} (7.78) was not significantly

different from the control. Overall, the fermented porridge had the best sensorial qualities.

Conclusion

Fermentation and germination processes were desirable for the development of sorghum based instant blended porridge. The processes added value through the improvement of the nutritional and sensory properties of sorghum porridge. Fermentation of sorghum was preferred and produced the best sensory properties. Both fermented and germinated porridges significantly increased the nutritional and physico-chemical properties and sensory characteristics of instant blended porridge compared to untreated sorghum porridge and the product goes well with water and milk after reconstitution. Future studies may be carried on vitamin and amino-acid profiling of the developed product to explore and validate the developed product.

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