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Effect of fenugreek (*Trigonella foneumgraecium*) seeds flour on amino acids profile, physical and organoleptic properties of Sudanese wheat bread

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Abstract:
Purpose - The aim of this study was to evaluate the effect of fenugreek seeds (raw (R.F) and germinated (G.F)) flour at 2%, 4% and 6% levels on amino acids profile ,physical and organoleptic properties of the supplemented wheat flour bread (loaf and baladi) .
Design/methodology/approach - Fenugreek seeds obtained from the local market were carefully cleaned, germination and a sample was milled into fine powder. Sudanese wheat grains obtained from the Agricultural Research Corporation (Wad Madani) were milled into white flour (72% extraction rate).The wheat flour was supplemented with 2%, 4% and 6% fenugreek flour (raw and germinated). Doughs from the flour mixes flour water absorption used according to farinograph results and fermented to produce two types of breads (loaf and baladi).The amino acids profile, physical and sensory attributes were determined in the control and supplemented breads. . **Findings** –The results indicated that the increasing the fenugreek flour level increased the amino acids content. Lysine in loaf and baladi breads ranged from 93.03 to 187.93 and from 92.16 to 184.24 mg/100 g respectively while control was 60.79 and 60.22 mg/100 g, respectively. Threonine ranged from 107.12 to 140.40 and from104.7 to 137.32 mg/100 g respectively while control was 91.43 and 89.36 mg/100 g, respectively. Specific volume of loaf bread was 3.74 and 4.53 cc/g for2% R.F and G.F respectively while control gained 4.32cc/g. Bread thickness of baladi bread showed no significant differences ($P \leq 0.05$) between control , (2,4,6 %) R.F and 6% G.F. The highest score for taste in loaf and baladi bread was gained by control (7.6 and 7.7) respectively followed by 2% R.F and G.F (6.4 and 6.9) respectively. On the other hand texture in baladi bread showed no significant difference ($P \leq 0.05$) between control and 2% R.F while the control gained highest reading in the loaf bread.
Originality/value - It can be concluded that substitution of 2% fenugreek flour (raw and germinated) into wheat flour gave bread with the best overall quality acceptance. While higher fenugreek flour level gave bread with higher lysine and threonine flour content.

Key words: *fenugreek; germinated fenugreek ; amino acids; Tin bread; Flat bread*.

I. INTRODUCTION:

With the increasing urbanization in developing countries, the demand of processed food is increasing rapidly. There is urgent need for cheaper foods rich in protein for individuals, taking into consideration their age, sex, physical activity and physiological needs. Therefore, there is a need for strategic use of inexpensive high protein resources that complement the balanced amino acid profile of the staple diet in order to enhance their nutritive value and overcome malnutrition problem in developing countries (Addisu 2011). Among the processed foods, bakery products have wide popularity in rural as well as urban areas among all the age groups (Agrawal, 1990). To augment the protein quality, the concept of cereal / legume complementation by blending cereal and legume flours can be applied. Fortification with high protein legume flours could provide a good opportunity to improve the nutritional quality of protein consumed by many people. Therefore, fortification of wheat flour with non-wheat flour was adopted for increasing the nutritional quality of wheat products by improving its amino acid profiles (Stark and Madar 1993). Fenugreek (*Trigonella foenum-graecum L.*) is an annual legume mainly used as a spice crop in many parts of the world. This crop is native to an area extending from Iran to northern India, but is now widely cultivated in China, North and East Africa, Ukraine and Greece (Petropoulos 2002). It is locally used as a pulse, spice and medicinal plant, and has a long history in Ethiopia (Gall and Zerihun 2009). Fenugreek seed can be utilized for value addition of cereals based food products to attain multiple benefits. It is used as a condiment and as a supplement to wheat and maize flour for bread making and as a constituent of the daily diet of general population in Indian subcontinent. It can be incorporated

in to food products, such as cookies, cereals, crackers, doughnuts, bagels, biscuits, pizza dough, pasta, bread, juices, salads, sauces, and candies. Its leaves are consumed widely in India as a green leafy vegetable and are a rich source of calcium, iron, β-carotene and other vitamins (Sharma et al 1996). In view of the above, the present study has been planned to evaluate blends of fermented and non fermented fenugreek with seeds flour wheat flour and perform the physico-chemical, functional and nutritional characteristics to assess its suitability for bread production.

II. Materials and methods:-

2.1Materials:

Fenugreek seeds were obtained from the local market. Sudanese wheat sample (imam) was brought from the Agricultural Research Corporation (Wad Madani).

2.1.2 Chemicals:

Chemicals and other materials were obtained from Food Research Center. Improver used was Ascorbic acid was obtained from the local market.

2.2 Methods:

2.2.1 Flour blends:

The wheat flour was supplemented with 2%, 4%, and 6% of germinated or raw fenugreek flour. The flour blends were mixed using laboratory mixing machine (Model: R100C, CAT, Chicago, 1970). The flour mixtures were individually blended, homogenized, packed in polyethylene bags and stored in air tight containers in a freezer until needed .

2.2.2 Determination of Amino acid profile:

The amino acids composition of all samples was determined according to the official methods using Sykam HPLC system (Model S7130). The system is equipped with a programmable auto injector.

The samples were prepared by placing 200 mg of each sample in hydrolysis tubes. Five milliliters of 6N-hydrochloric acid were added to each and tightly closed. The tubes were incubated at 100°C for 24 hours. The hydrolysate of each sample was then filtered using 125 mm filter paper. A 200 µl of the filtrates were evaporated at 140°C for about an hour. A diluted buffer was added to the dried samples and then the samples were ready for analysis.The HPLC system was calibrated with a standard amino acid kit solution and then the sample hydrolysate was injected into the HPLC analyzer system with an auto injector.

2.2.3 Loaf bread

The procedure described by Badi, et al., (1978) . Dry ingredients (flour 250 g, dry yeast 2.5 g, salt 1.5 g and sugar 3 g + raw and germinated fenugreek at different levels (2, 4 and 6%) were mixed for 1 min. using Mono – Universal laboratory dough mixer. Water was added (based on the farinograph optimum absorption) and mixed for 3 min at medium speed. After mixing the dough was allowed to rest for 10 min. at room temperature (38±2°C), scaled to three portions of 120 g each, molded into round balls and allowed to rest for another 10 min. then molded, put in pans and transferred into the fermentation cabinet for 45 min.

The fermented dough's were then baked in Simon Rotary baking oven at 250°C for 20 min.

2.2.4 Physical characteristics of loaf bread:

The loaves were left to cool for 1 hr at room temperature (38±2°C).

2.2.5 Bread weight:

Bread loaves were weighed 20 min after baking, using a laboratory balance (CE- 410I, Camry Emperors, China) and the readings were recorded in grammes.

2.2.6 Bread volume:

The loaf volume was determined by the seed displacement method according to Pyler (1973). The loaf was placed in a container of known volume into which small seeds (millet seeds) were run until the container is full. The volume of seeds displaced by the loaf was considered as the loaf volume.

2.2.7 Bread specific volume:

The specific volume of the loaf was calculated according to the AACC method (2000) by dividing volume (CC) by weight (g).

2.2.8 Sensory evaluation of loaf bread:

The loaves were sliced with an electric knife and prepared for sensory evaluation same day. The sensory evaluation of bread sample was carried for aroma, taste, crumb texture, crumb color, crumb cell uniformity, general acceptability conducted by 10 semi trained panelists. During sensory evaluation, panelists were instructed to drink water or rinse their mouths to clear the palate after each evaluation. Sensory evaluation was done on theSame day that the breads were prep

2.2.9 Flat bread:

The procedure described by Qarooni et al (1987, 1993) . Dry ingredients (flour 250 g, sugar 2.5 g, salt 2.5 g and dry yeast 5 g + raw and germinated fenugrrek flours at different levels (2,4,6%), were mixed for 1 min. using Mono – Universal laboratory dough mixer. Water was added and mixed for 6 min. at medium speed. The optimum amount of water was determined using the formula of Quarooni (1989) and Qarooni et al., (1993), with some modifications (baking absorption % = 20 + 0.596 × optimum water absorption from the farinograph). After one hour of bulk fermentation at 30°C and 85% humidity (rh) the dough was divided into pieces of 60 g, rounded by hand, covered and allowed to relax for 15 min. in the fermentation cabinet. Dough pieces were flattened by hand and cross sheeted (0.8 mm thickness). All sheeted doughs were put on a wooden board and transferred into the proofing cabinet for 30 min. at 30°C and 85% rh. The proofed pieces were put on a pre – heated solid aluminum tray and baked at 400°C for 2 min.

Loaves were cooled for 15 min. and wrapped in plastic bags then kept at room temperature (38±2°C) for one hour.

2.2.10 Physical characteristics of flat bread:

Flat bread was evaluated for thickness (cm) and diameter (cm).Three breads were used for the evaluation, the average was noted.

2.2.11 Sensory evaluation of flat bread:

The bread pieces were prepared for sensory evaluation same day. The sensory evaluation of bread samples, was carried for aroma, taste, crust color, general acceptability was carried out by 10 semi trained panelists. During sensory evaluation, panelists were instructed to drink water or rinse their mouths to clear the palate after each evaluation. Sensory evaluation was done on the same day that the breads were prepared. (see Appendix 2).

2.2.12 Statistical analysis:

The analysis of variance was performed to examine the significant effect in all parameters measured. Duncan Multiple Range Test was used to separate the means.

III. Results and discussion:-

3.1 Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Physical characteristics of loaf bread:

Physical characteristics: of loaf bread made from wheat flour, and fenugreek flours) raw and germinated) at different levels are shown in Table (1). Bread with germinated fenugreek seeds flour showed increase in loaf bread weight with increasing in level of germinated fenugreek(G.F) flour, this result agrees with Drees and Hoseney (1982) result which indicate that an extra quantity of water was retained in breads after baking . From the table no significant ($P \leq 0.05$) difference was observed between control and 2% raw fenugreek (RF). Volume of Loaf bread with 2% RF or GF have significantly higher value than control loaf bread, 471.70, 490 and 451.7 cc respectively. Loaf specific volume of bread made from wheat flour and fenugreek flour raw and germinated (2, 4 and 6%) ranged between 4.72 and 3.72 cc/g. The 2 % G.F and 2% RF flours gained the highest bread specific volume 4.53cc/g, and 4.51cc/g respectively, whereas the 4% of RF flour gave the lowest bread specific volume 3.72cc/g this can be attributed to lower levels of gluten network in the dough and consequently less ability of the dough to rise; due to the weaker cell wall structure.

3.2 Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Physical characteristics of baladi bread:

Baladi bread made from wheat flour, with fenugreek flours raw and germinated at different levels are shown in Table 2. Baladi bread weight ranged between 123 and114g . 6% RF gave the lowest weight whereas the highest weight was gained by 2 %R.F. Loaf diameter increased with increasing level of RF and GF. Significant ($P \leq 0.05$) difference between control and 2% RF was not noticed. In the same table the result showed that the baladi bread thickness ranged between 2.13 and 1.13 cm from the table no significant ($P \leq 0.05$) difference was observed between control and all levels of raw fenugreek flour (RF) and 6% G.F . while 4%

G.F gave the lowest thickness This may be due to lower levels of gluten network in the dough and consequently less ability of the dough to rise; due to the weaker cell wall structure.

3.4 Sensory evaluation of loaf bread:

Sensory evaluation of loaf bread made from wheat flour, and fenugreek flours with different treatments at different levels are shown in table 3.The scores of aroma of loaf bread made from wheat flours with and without fenugreek flour with certain levels are shown in Table 3.The scores of taste ranged between 7.6 to 2.2 the control gained the highest while the 6% GF recorded the lowest value. The taste scores decreased with increasing level of the treatments and there is no significant (P≤0.05) difference among the control and RF2%. The lowest taste score may be due to the phenolic compounds and tannins found in the seed coat of fenugreek. The crust color scores of the loaf bread made from wheat flour and fenugreek flour (raw and germinated) was found to be in the range of 8.2 to 2.1. A highest crust color was gained by control while 6% G.F gave the lowest value may be because of the greater amount of the maillard reaction between reducing sugars and proteins.The scores of crumb texture decreased significantly (P≤0.05) with increasing fenugreek flour may be due to replacement of wheat flour with fenugreek flours decreased cohesiveness, and resilience in bread samples.flour. The crumb taste score ranged between 7.1, 2.4 the highest value was provided by the control followed by2% R.F. It was observed that the score of the taste decrease with increasing the level of the raw and germinated fenugreek due to bitterness in the seeds flour . The scores of crumb grain of loaf bread ranged from 8.0 to 2.6 for control and 6% for germinated fenugreek flour respectively. The raw fenugreek flour bread samples with different levels gained the highest scores of crumb grain. The lowest score was obtained by germinated fenugreek flour with different levels and showed significant difference (P≤0.05) between 4% GF and 6% GF. The scores of bread general acceptability are found to be in the range of 8.2 to 2. The control and 2% R.F gained highest scores with significant differences (P≤0.05) when compared with 4% and 6% R.F.

3.5 Sensory evaluation of baladi bread samples:

Sensory evaluation of baladi bread made from wheat flour, and fenugrrek flours with different treatments at different levels are shown in table 4. The scores of aroma of the baladi bread ranged between 4.6 and 8.5. The control gained the highest value followed by the 2% R.F, whereas the 6% G.F gave the lowest value.

Table 1: Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Physical characteristics of loaf bread.

Bread treatment	Loaf volume (cc)	Loaf weight (gm)	Loaf specific volume cc/g
Control (100% wheat flour)	451.70±2.89c	104.50±0.64e	4.32±0.00b
R.F (2%)	471.70±15.28b	104.60±0.49e	4.51±0.13a
R.F (4%)	408.30±7.64d	109.60±0.67b	3.72±0.06e
R.F (6%)	400.00±0.00d	107.00±0.42d	3.74±0.01e
G.F (2%)	490.00±8.66a	108.10±0.80d	4.53±0.05a
G.F (4%)	453.30±5.77c	108.70±1.10c	4.17±0.05c
G.F (6%)	441.70±7.64c	111.40±0.64a	3.96±0.09d
SE±	14.30*	1.240*	0.1238*
Lsd0.05	4.714	0.4087	0.04082

* Mean ± SD value(s) bearing different superscripts within columns are significantly (P≤0.05)
2% R.F = bread with 2% raw fenugreek flour.
4% R.F = bread with %4 raw fenugreek flour.
6% R.F = bread with %6 raw fenugreek flour.
2% G.F = bread with 2% germinated fenugreek flour.
4% G .F =bread with 4% germinated fenugreek flour.
6% G.F = bread with %6germinated fenugreek flour.

Table 2: Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Physical characteristics of baladi bread.

Bread treatment	Bread weight (gm)	Bread diameter (cm)	Bread thickness (cm)
Control	120.30 ± 2.33^{bcd}	11.17 ± 0.06^{c}	2.13 ± 0.06^{a}
R.F (2%)	120.90 ± 1.71^{abc}	10.83 ± 0.31^{c}	2.00 ± 0.10^{a}

R.F (4%)	121.70±1.28^{ab}	12.67±0.06^{ab}	2.07±0.15^{a}
R.F (6%)	114.50±0.06^{e}	12.27±0.12^{b}	1.90±0.20^{a}
G.F (2%)	117.30±0.58^{de}	12.43±0.25^{ab}	1.23±0.06^{b}
G.F (4%)	118.30±2.36^{cd}	13.03±0.12^{a}	1.13±0.12^{b}
G.F (6%)	123.80±1.86^{a}	12.00±0.87^{b}	1.90±0.17^{a}
SE±	2.912*	0.6458*	0.2349*
$Lsd_{0.05}$	0.9602	0.2129	0.07746

* Mean values in each column having different superscript letters differ significantly (P ≤ 0.05)
2% R.F = bread with 2% raw fenugreek flour.
4% R.F = bread with %4 raw fenugreek flour.
6% R.F = bread with %6 raw fenugreek flour.
2% G.F = bread with 2% germinated fenugreek flour.
4% G .F =bread with 4% germinated fenugreek flour.
6% G.F = bread with %6germinated fenugreek flour.

From the present results, it is clearly shown that the aroma scores decreased with the increase of the levels of replacement of wheat flour by treated Fenugreek flour. No significant (P≤0.05) difference was observed between the control and 2%R.F. Also no significant (P≤0.05) difference was noticed between 2%,4% R.F and 2% G.F. But no significant difference (P≤0.05) was observed between 4%G.F and 6% G.F .The taste scores of the breads were found to be in the range of 7.7 to 5. The Control gained the highest value followed by2% RF may be due to the phenolic compounds and tannins found in the seed coat. with significant (P≤0.05) difference, whereas the 4% G.F. gained the lowest scores in all levels. Whereas no significant (P≤0.05) difference between 4%, 6% R.F and 4%,6% G.F was noticed. No Significant (P≤0.05) difference between 2% R.F and 2%G.F was shown.The scores of crust color are found to be in the range of 4.9 to 7.8. A higher crust color score was gained by 2%R.F while 4% R.F gave the lowest value(4.9), and no significant (P≤0.05) difference between Control and 2% R.F also between 2% ,4% and 6% G.F were shown . With significant difference between 2% RF and 4% R.F also there was significant difference between 2, 6% G.F and 4%G.F may be because of the greater amount of the maillard reaction between reducing sugars and proteins. The scores of crumb texture 2% raw fenugreek flour and control bread provided highest scores with no significant difference (P≤0.05) between them. The lowest score was indicated by the bread with 4% germinated fenugreek flour could be retention of moisture in the crumb results from the production of too – many dextrins from the starch and the

Table 3: Effect of incorporation of different levels of raw and germinated fenugreek flour seeds on Sensory evaluation of loaf bread.

Samples	Quality attributes					
	Aroma	Taste	Color	Texture	Crumb grain	General acceptability
	Hedonic scores					
Control	7.90±1.45^{a}	7.60±2.5^{a}	8.20±1.4^{a}	8.00±1.49^{a}	8.00±1.89^{a}	8.20±1.23^{a}
R.F(2%)	6.40±1.71^{b}	6.40±2.27^{a}b	7.00±1.33^{b}	6.90±1.91^{ab}	7.00±1.70^{ab}	6.80±1.55^{b}
R.F (4%)	5.90±1.52^{bc}	5.20±1.69^{bc}	6.20±1.14^{b}	5.80±1.62^{bc}	6.10±1.45^{bc}	5.90±1.20^{bc}
R.F (6%)	4.50±0.97^{de}	4.50±1.58^{c}	4.60±1.35^{c}	4.50±1.65^{cd}	4.90±1.73^{cd}	4.60±1.26^{d}
G.F (2%)	4.90±0.99^{cd}	4.60±1.07^{c}	4.60±1.26^{c}	5.10±1.60^{cd}	4.50±1.96^{de}	5.20±1.23^{cd}
G.F (4%)	3.50±1.08^{e}	3.60±1.43^{cd}	3.30±1.06^{d}	4.00±1.94^{de}	3.30±1.42^{ef}	3.20±1.32^{e}
G.F (6%)	0.88±1.90^{f}	1.40±2.20^{d}	1.29±2.10^{e}	1.58±2.60^{e}	1.43±2.60^{f}	1.32±2.20^{e}
SE±	*1.131	*1.589	*1.097	*1.512	*1.489	*1.166
$Lsd_{0.05}$	0.4004	0.5624	0.3883	0.535	0.5268	0.4127

* Mean values in each column having different superscript letters differ significantly (P ≤ 0.05).
2% R.F = bread with 2% raw fenugreek flour.
4% R.F = bread with %4 raw fenugreek flour.
6% R.F = bread with %6 raw fenugreek flour.
2% G.F = bread with 2% germinated fenugreek flour.
4% G .F =bread with 4% germinated fenugreek flour.
6% G.F = bread with %6germinated fenugreek flour.

loss of gluten structure . The scores of bread general acceptability are found to be in the range of 8.2 to 5.3. The control of bread gained highest score

Whereas, the bread with 4% germinated Fenugreek flour gave the lowest score with no significant difference (P≤0.05) between 4%, 6% R.F and 2%, 4%, 6% G.F respectively could be due to (aroma, taste, crust color, crumb texture) effect in general acceptability.

3.6 Amino acid profile of loaf bread:

The amino acid composition of the loaf bread made from wheat flour, and raw and germinated fenugreek flours with different levels are shown in table 5 which indicated wide variation in the contents of total essential and nonessential amino acids. Lysine content of the wheat flour loaf bread (control) was 60.79mg/100g while wheat flour loaf bread containing 2, 4, 6% raw fenugreek flour has 93.03, 125.27 and 157.51mg/100g, respectively .Whereas wheat flour loaf bread with 2,4 and 6% germinated fenugreek flour contained 103.17,145.55and187.93mg/100g respectively.Loaf bread containing 6 % GF showed the highest values of the amino acids methionine and histidine 114.59, 182.62 mg/100g respectively. Leucine maximum values were obtained by wheat flour loaf bread containing RF at the three different levels followed by 6% G.F and control respectivley while minimum values were observed by wheat flour with 2and 4 % GF. Result of the nonessential amino acids showed that GF gave the highest value of serine, glycine and argenine, while the lowest value was found in the wheat flour loaf bread (control). Aspartic acid and alanine showed the highest values in loaf bread with 2, 4 and 6% GF flour .In the case of glutamic acid wheat flour loaf bread, as expected, has high content and loaf bread containing 2,4and6%GF had the lowest amount, whereas loaf bread whith 2,4and 6% R.F had the highest glutamic acid content due to In vitro protein digestibility, protein efficiency ratio and essential amino acid index were improved by germination (Shibin El-Kom, 2006).

3.7 Amino acid profile of baladi bread:

The amino acid composition of the baladi bread made from wheat flour with raw and germinated fenugreek flours at different levels are shown in Table 6. The results indicated wide variation in the contents of total essential and nonessential amino acids. Results are in agreement with the results in table No 5, except bread containing 2% G.F which showed higher readings in glutamic acid and alanine. Generally the results showed decrease in essential and nonessential amino acids in baladi bread compared with loaf bread, may be due to the high baking temperature of the baladi bread resulting in distruction of some of the amino acids or induced Millard reaction or both.

3.8 Limiting essential amino acids:

Lysine and threonine are considered to be exceedingly important in that they are the most limiting essential amino acids in cereal grains, (Bright and, Shewry, 1983). The Limiting essential amino acids Lysine and threonine in the tin and Baladi breads made from wheat flour, with raw and germinated fenugreek flours with different levels are shown in tables (5 and 6).The result showed that incorporation of R.F. or G.F. in wheat flour breads have increased the limiting amino acids (Lysine and threonine).

Table 4: Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Sensory evaluation of baladi bread samples.

Samples	Quality attributes				
	Aroma	Taste	Texture	Crust color	General acceptability
	Hedonic scores				
Control	8.50 ± 0.53^{a}	7.70 ± 1.42^{a}	7.40 ± 1.58^{a}	7.70 ± 1.49^{a}	8.20 ± 0.79^{a}
R.F (2%)	7.10 ± 1.52^{ab}	6.90 ± 1.60^{ab}	6.90 ± 2.33^{a}	7.80 ± 1.14^{a}	7.20 ± 1.99^{ab}
R.F (4%)	6.00 ± 2.31^{bc}	5.10 ± 1.97^{b}	6.00 ± 1.83^{ab}	4.90 ± 1.37^{c}	5.70 ± 1.64^{b}
R.F (6%)	5.50 ± 2.12^{bc}	5.10 ± 2.42^{b}	4.70 ± 2.06^{b}	5.80 ± 2.44^{bc}	6.00 ± 2.36^{b}
G.F (2%)	6.30 ± 1.42^{bc}	5.90 ± 1.97^{ab}	6.10 ± 1.73^{ab}	7.10 ± 1.60^{ab}	6.30 ± 2.36^{b}
G.F (4%)	4.80 ± 2.53^{c}	4.90 ± 1.91^{b}	4.40 ± 1.58^{b}	6.30 ± 2.36^{abc}	5.30 ± 2.00^{b}
G.F (6%)	2.80 ± 4.60^{c}	2.62 ± 5.00^{b}	1.99 ± 6.20^{ab}	2.11 ± 7.30^{ab}	2.46 ± 5.50^{b}
SE±	$^{*}1.808$	$^{*}1.81$	$^{*}1.686$	$^{*}1.652$	$^{*}1.801$
$Lsd_{0.05}$	0.6399	0.6407	0.5967	0.5846	0.6374

*Mean values in each column having different superscript letters differ significantly (P ≤ 0.05).

Table 5: Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Amino acids of loaf bread.

Amino Acid	Control	Samples (mg/100g)					
		Germinated fenugreek			Raw fenugreek		
		2%	4%	6%	2%	4%	6%
Aspartic acid	226.20	239.00	251.81	264.62	280.49	334.78	389.07
Therionine	91.43	107.75	124.08	140.40	107.12	122.82	138.51
Serine	130.56	220.65	310.73	400.82	146.25	161.94	177.63
Glutamic acid	2008.71	1987.27	1965.83	1944.4	2064.55	2120.38	2176.22
Glycine	19.46	48.89	78.32	107.75	38.54	57.61	76.68
Alanine	408.26	402.68	397.11	391.54	430.07	451.38	473.69
Methionine	25.32	55.07	84.83	114.59	28.46	31.60	34.73
Isoleucine	239.82	275.96	312.11	348.25	267.10	294.38	321.65
Leucine	466.67	465.73	464.79	483.85	499.70	532.73	565.76
Tyrosine	12.52	35.43	58.34	81.24	21.34	30.16	38.98
Phenylalanine	286.88	294.61	302.35	310.09	306.34	325.79	345.25
Histidine	88.33	119.76	151.19	182.62	100.05	111.78	123.51
Lysine	60.79	103.17	145.55	187.93	93.03	125.27	157.51
Ammonia	706.00	744.63	783.26	821.89	730.29	754.58	778.88
Agrinine	296.44	356.86	417.27	477.69	346.46	396.49	446.51
Total	6847.60	5457.47	5847.57	6237.67	5459.78	5852.19	6244.60

Table 6: Effect of incorporation of different levels of raw and germinated fenugreek seeds flour on Amino acids profile of baladi bread.

Amino Acid	Control	Samples (mg/100g)					
		Germinated fenugreek			Raw fenugreek		
		%2	%4	%6	%2	%4	%6
Aspartic acid	222.59	254.26	247.79	260.40	276.01	329.44	382.86
Therionine	89.36	105.32	121.28	137.23	104.70	120.04	135.38
Serine	127.36	235.23	303.11	390.99	142.66	157.97	173.27
Glutamic acid	1966.77	2074.40	1924.79	1903.80	2021.45	2076.12	2130.79
Glycine	18.86	50.93	75.87	104.38	37.33	55.81	74.28
Alanine	398.95	417.29	388.06	382.62	420.26	441.58	462.89
Methionine	24.89	57.73	83.41	112.66	27.98	31.07	34.15
Isoleucine	236.03	290.79	307.17	342.74	262.88	289.72	316.57
Leucine	457.09	456.17	455.25	454.33	489.45	521.80	554.15
Tyrosine	12.04	34.95	57.55	80.15	20.53	29.01	37.49
Phenylalanine	288.08	289.97	297.58	305.20	307.62	327.17	346.71
Histidine	84.36	117.31	148.10	178.89	95.56	106.76	117.96
Lysine	60.22	103.70	142.69	184.24	92.16	124.11	156.05
Ammonia	677.47	752.15	775.35	813.59	700.78	724.10	747.41
Agrinine	299.19	367.51	414.69	474.74	349.67	400.16	450.65
Total	5089.74	5607.72	5742.71	6125.97	5349.06	5734.85	6120.63

IV. CONCLUSION

It can be concluded that substitution of 2% fenugreek flour (raw and germinated) into wheat flour gave bread with the best overall quality acceptance. While higher fenugreek flour level gave bread with higher lysine and threonine flour content.

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