IJFANS
International Journal of Food And Nutritional Sciences

Volume 4, Issue 4, Jul-Sep 2015, www.ijfans.com e-ISSN: 2320-7876

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

IMPACT FACTOR ~ 1.021

Official Journal of IIFANS

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

e-ISSN 2320 –7876 *www.ijfans.com*
Vol.4, Iss.4, Jul-sep, 2015

Research Paper *Open Access*

ORGANOLEPTIC AND NUTRITIONAL EVALUATION OF GLUTEN FREE PRODUCTS FROM QUINOA (*Chenopodium quinoa*) GRAIN

Simranpreet Kaur Bhathal*, Navjot Kaur and Kiran Grover
Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana

*Corresponding Author: simrankaurbhathal@yahoo.com

Received on: 13th August, 2015 **Accepted on: 14th September, 2015**

ABSTRACT

The study was aimed for the development and organoleptic evaluation of products using quinoa grain and to estimate the nutritional composition of the products. Four products namely sweet porridge, vegetable porridge, fruit *chat* and cutlets were developed from quinoa grain and were treated as test samples. Products like sweet porridge, vegetable porridge, fruit *chat* and cutlets were found to be highly acceptable with overall acceptability score of 8.04 for sweet porridge, vegetable porridge (8.02), fruit chat (8.26) and cutlets (8.12). Fruit *chat* was found to be highly acceptable among all the products due to addition of seasonal fruits along with quinoa grain. Nutritional analysis revealed that test samples prepared from quinoa grain have higher crude protein ranging from 12.45 to 19.40%, crude fat 5.24 to 29 %, total ash 1.12 to 3.03% and crude fibre 2.28 to 3.75% as compared to controls. Energy content of all the test samples was also found to be higher as compared with controls. Mean scores of lysine, tryptophan and methionine content of test samples also showed significant difference ($p<0.05$) as compared to control. Lysine which is a limiting amino acid in cereals, have significant higher values ranging from 11.45-19.78g/100g protein among the developed products. Calcium, magnesium, iron and zinc content of test samples were also found to be significantly ($p<0.05$) higher as compared to control. Neutral Detergent Fibre (NDF) values ranged from 36.80 % to 74.70 % and Acid Detergent Fibre values ranged from 19.20 to 28.80 for test samples. Quinoa grain products were found to be highly acceptable and nutritionally better as compared to the control samples.

Keywords: Quinoa grain, organoleptic evaluation, nutritional composition, amino acids and mineral content.

INTRODUCTION

Rising demands for gluten free products parallels the increase in celiac disease. The development of foods rich in essential compounds such as amino acids, minerals, fibres and fatty acids that are also free of anti-nutritional factors is necessary particularly due to the dietary restrictions of celiac disease sufferers. Products made from corn, rice, soybean, tapioca, amaranth seeds and pseudo cereal such as Quinoa can be included in the diet of celiac patients (Loverday *et al* 2009). Quinoa (*Chenopodium quinoa*) is a species of goosefoot (*Chenopodium*) a grain crop grown primarily for its edible seeds. It is a staple food of ancient civilizations and got originated in the Andean region of South America. It has exceptionally high protein (13-16%) and more than 37% of the protein in Quinoa comprises of essential amino acids like that of the milk protein, casein. Unlike wheat, rice and corn which are low in lysine, Quinoa contain balanced set of essential amino acid such as methionine, cysteine and lysine and also making Quinoa a good complement to legumes which are limiting in these amino acids (Drzewiecki *et al* 2003). Quinoa grains contain large amounts of minerals like Ca, Fe, Zn, Cu and Mn (Repo *et al* 2003). Quinoa can be successfully incorporated into various foods, based on the type of food and the manufacturing process. Addition of Quinoa increases vitamins and minerals, protein content and quality, and improves the taste by contributing a nutty flavor to the food product. With the use of such products the nutritional and therapeutic benefits of Quinoa can be added to the diet of an individual and can be a boon for celiac patients. Quinoa is an emerging novel pseudo cereal which is gluten free and a source of natural health promoting compounds.

MATERIAL AND METHODS

SAMPLE SELECTION

The samples of Quinoa (*Chenopodium quinoa*) were procured from the local market. For standardization of food products developed by using Quinoa, commonly consumed food items i.e. milk, vegetables and fruits were procured from the local market along with other ingredients like oil, spices, sugar and salt.

METHOD

Quinoa grains were used in sweet porridge,

vegetable porridge, fruit *chat* and cutlets. The developed products were organoleptically evaluated by a trained panel of 10 judges from Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana. The judges were served each preparation with one control and one experimental sample. Control sample was prepared from ingredients used in the usual recipes and test sample was prepared by using quinoa. The samples were coded as C and S_1 to avoid any bias. Each product was tested thrice. Judges were asked to score the samples for colour, appearance, flavour, texture, taste and overall acceptability using a score card of 9 point Hedonic Rating Scale.

PROXIMATE ANALYSIS

Ground samples of raw and cookies samples were analysed for their proximate contents using (AOAC 2000) method. The moisture content was determined by air -oven drying at 105˚C for 8 hrs and crude protein contents by microkjeldhal method. The fat content was determined using petroleum ether (bp. 60-80°C) in a soxhlet extraction apparatus and crude fibre content by dilute acid and alkali hydrolysis. Carbohydrate content was calculated by difference of total contents from 100.

AMINO ACID CONTENT

The amino acid content of samples was done. Three amino acids were studied i.e. tryptophan estimation by using Concon (1975) method and methionine estimation by Horn *et al* (1946) method. The estimation of available lysine (Carpenter, 1960 modified by Booth, 1971) was done. This procedure involves conversion of lysine residues with reactive epsilon amino group in the food proteins into a yellow epsilon dinitrophenyl lysine by treatment with fluorodinitrobenzene followed by acid hydrolysis. Ether soluble interfering compounds are removed by extraction and extinction of the residual aqueous layer is measured.

MINERAL CONTENT

Minerals like calcium, iron, magnesium and zinc content of samples were estimated by atomic absorption spectrophotometer. The samples were prepared by wet digestion method. Representative sample in a suitable liquid form is sprayed into the flame of an atomic absorption spectrophotometer and the absorption or emission of the mineral to be analyzed was measured at a specific wavelength.

FIBER FRACTIONS

The samples were estimated for neutral detergent fibre and acid detergent fibre by Goering and Van Soest (1970) method.

STATISTICAL ANALYSIS

All determinations were carried out in triplicate and results were expressed as mean ± standard error. The data was analysed with the help of various statistical tools. To test the significant difference between the control and experimental samples two tail t – test was applied using SPSS 16 software. The significant difference was checked at 5% and 1% level of significance.

RESULTS AND DISCUSSION

ORGANOLEPTIC EVALUATION OF DEVELOPED PRODUCTS USING QUINOA GRAIN

Data regarding organoleptic evaluation of products is presented in the Table 1. Samples of vegetable porridge were prepared using broken wheat grain as a control sample (C) and for test sample quinoa grain was used (S_1). The results showed that on the basis of overall acceptability scores, test sample scored significantly higher scores than the control and was most acceptable. The control sample of sweet porridge was given scores ranging from 7.10 to 7.50. It was observed that the test sample was found to have the high mean scores for appearance, colour, texture, flavour ranging from 7.8 to 8.3 with an overall acceptability score of 8.04 which was liked very much followed by control sample with an overall acceptability score of 7.30 resulted in moderate likeness. Khetarpaul *et.al* (2004) determined the acceptability of porridge developed from various proportions of soy and sorghum. Partially defatted soy dhal was soaked in four salt solutions namely, sodium carbonate, sodium bicarbonate, sodium tripolyphosphate and sodium chloride. Soaked dhal was dried and made into grits. Soy and sorghum grits were mixed in three proportions i.e. 10:90, 20:80 and 30:70 to develop nutritious porridge. Porridge prepared from wheat grits served as a control. Porridge prepared using sodium carbonate soaked soy dhal was found to fall in the 'like slightly' category whereas other three types of porridges as well as control porridge were 'liked moderately' by the panelists. Barka *et.al* (2004) developed a sweet porridge by supplementing rice to broken wheat at 25%, 30% and 40% level. It was concluded that the most acceptable level of supplementation was 30%. Sharma (2009) also conducted trails by preparing samples of sweet porridge by supplementing oats at 20%, 25% and 35% level. Highest scores of 7.9 and 7.7 were obtained for taste and overall acceptability at 25% level.

Samples of sweet porridge were prepared using broken wheat grain along with vegetables as a control sample (C) and for test sample quinoa grain along with vegetables was used (S_1).

The results revealed that control sample of vegetable porridge were given a scores ranging from 7.30 to 7.70 for different quality attributes with an overall acceptability score of 7.52. Test sample scored significantly higher scores than the control sample in all the parameters. The mean scores for appearance, colour, texture, flavour and taste of test sample were significantly higher i.e 7.90, 7.90, 7.90, 8.00 and 8.40 than that of control sample i.e. 7.60, 7.70, 7.30, 7.50 and 7.50. The appearance and colour showed no significant differences with the control sample. The mean score of overall acceptability of test i.e. 8.02 was significantly higher than the control i.e. 7.52. The test sample was liked very much

and was more acceptable than the control sample which was moderately liked. Edema *et al* (2005) reported the salty porridge developed from supplementation of soya with wheat in 9:1 ratio was highly acceptable by the panelists. Flander *et al* (2007) reported that 10-20% of broken wheat can be easily replaced by oats in conventional porridge. Mandge *et.al* (2014) conducted study on sensory attributes (appearance, mouth feel, flavor and overall acceptability) of instant multigrain porridge, instantized by cooking treatment. Appearance, mouth feel and flavor changed non-significantly under different processing treatments. Mean overall acceptability of multigrain porridge prepared by soaking at 65°C was higher than that of samples given soaking treatment at 50°C. Sharma *et.al.*, (2009) conducted trials by supplementing oats at 20%, 25% and 30% level to broken wheat. There was significant difference in all sensory parameters of 30% and 20% levels which are liked moderately in comparison to control.

The test sample (S_1) of fruit *chat* was prepared by using fruits and the boiled form of quinoa and control sample (C) was prepared from fruits only. The results revealed that the test sample have higher scores than the control in all the parameters. The test sample has scores ranging from 8.10 to 8.40. The mean scores for appearance, colour, texture, flavour and taste of test sample were significantly higher i.e. 8.40, 8.30, 8.10, 8.30 and 8.20 than that of control fruit *chat* i.e. 7.70, 7.60, 7.50, 7.70 and 7.70. The appearance, colour and flavour of test sample were liked very much due to the addition of quinoa grain in boiled form. The mean scores of overall acceptability of test fruit *chat* i.e. 8.26 were significantly higher than the control i.e. 7.64.

The test sample (S_1) was prepared with quinoa as a main ingredient in which quinoa grains were boiled and then it was incorporated along with potatoes and other vegetables whereas control product (C) was prepared using potatoes and vegetables only.

The results revealed that the test sample which was prepared by incorporation of quinoa exhibited significantly higher scores than the control sample for all the sensory parameters. The control sample was given a scores ranging from 7.40 to 7.60. It was observed that due to addition of quinoa in test sample, it was liked very much in terms of texture and flavour. The mean scores for appearance, colour, texture, flavour and taste of control cutlets were significantly higher i.e. 7.60, 7.60, 7.70, 7.40 and 7.40 than that of test sample i.e. 8.10, 8.10, 8.20, 8.20 and 8.00. The test sample was liked very much as the sample was considered to be very nutritious as it contains both quinoa as well as vegetables. The mean score of overall acceptability of test sample i.e. 8.12 was significantly higher than the control i.e. 7.54. Kaur (2011) prepared the four samples of *tikki* using fresh potatoes, rice flakes and Bengal gram *dal* for control and for test samples fresh potatoes were substituted with 30%, 35% and 40% level of potato flour. Mean scores of acceptability of S_1 (30%), S_2 (35%) and S_3 (40%) showed significant difference ($p<0.05$) as compared to control.

Table 1 Organoleptic evaluation of developed products using quinoa grain.

Products	Appearance	Colour	Texture	Aroma	Taste	Overall acceptability
Sweet porridge						
Control	7.40±0.16	7.30±0.15	7.50±0.17	7.40±0.16	7.10±0.10	7.36±0.12
Experimental	8.30±0.15	8.10±0.18	8.10±0.10	7.90±0.10	7.80±0.20	8.04±0.10
t-value	4.02**	3.39**	3.09**	2.61*	3.13**	4.34**
Vegetable porridge						
Control	7.60±0.16	7.70±0.15	7.30 ±0.21	7.50±0.17	7.50±0.17	7.52±0.14
Experimental	7.90 ±0.10	7.90±0.10	7.90 ±0.10	7.80±0.15	8.40±0.16	8.02±0.03
t-value	1.57^{NS}	1.10^{NS}	2.54*	2.23*	3.86**	3.25**
Fruit *chat*						
Control	7.70±0.15	7.60±0.16	7.50±0.17	7.70±0.15	7.70±0.15	7.64±0.07
Experimental	8.40±0.16	8.30±0.15	8.10±0.10	8.30±0.15	8.20±0.13	8.26±0.12
t-value	3.13**	3.13**	3.09**	2.78*	2.47*	4.45**
Cutlets						
Control	7.60±0.16	7.60±0.16	7.70±0.15	7.40±0.16	7.40±0.16	7.54±0.09
Experimental	8.10±0.10	8.10±0.10	8.20±0.13	8.20±0.13	8.00±0.00	8.12±0.06
t-value	2.61*	2.61*	2.47*	3.80**	3.67**	5.34**

PROXIMATE COMPOSITION

The proximate composition of the test sample (S_1) and control sample (C) on dry matter basis is given in the Table 2. For all the parameters of proximate composition, the difference between control and test sample was found to be statistically significant. The moisture content of 4.66% was observed in control sweet porridge while the test sweet porridge prepared from quinoa contain significantly less moisture of 2.66%. The ash, crude fat and crude fibre of test sample i.e. 2.20%, 29% and 2.28% respectively was significantly higher than that of control sweet porridge in which ash content was 1.15%, crude fat 24% and crude fibre 1.63%. Barka *et al* (2004) reported 2.6% crude fibre content of wheat porridge made by

supplementing rice to broken wheat. The protein content in test sweet porridge 19.40% was significantly higher than control sweet porridge 15.65% which was due to the addition of quinoa grain. Barka *et al* (2004) reported the crude protein content of sweet porridge made from supplementing rice to broken wheat to be 2.3%. The carbohydrate content was observed in control as 52.81% and test sweet quinoa porridge was 44.46%. The energy content of test sweet porridge with 516 Kcal was significantly higher than the control with 490 Kcal.

The moisture content of control sample of vegetable porridge was 2.88% while the test vegetable porridge contains significantly less moisture of 1.92%. For all the other parameters of proximate composition, difference between control and test sample was found to be statistically significant. The protein content in test sweet porridge 14.65% was found to be significantly higher than control sweet porridge 11.75% as quinoa is a good quality protein source. The ash, crude fat and crude fibre of test sample i.e. 2.40%, 12.07% and 2.96% respectively was significantly higher than that of control sweet porridge in which ash content was 2.20%, crude fat 10.43% and crude fibre 1.77%. Edema *et al* (2005) reported the crude protein and crude fibre content of porridge supplemented with in ratio of 9:1 to be 8.0% and 1.4%. The fat content of salty *dalia* supplemented with 25% oats was 6.2% and that of control was observed to be 5.5% with no significant difference. Swain and Curley (2008) evaluated oat porridge and concluded lower values of crude protein i.e. 2.1% and 7.2% of crude fibre and 4.4% of crude fat. The carbohydrate content was observed in control as 70.97% and test sweet quinoa porridge with 66% which was significantly lower than the control sample. The energy content of test sweet porridge with 448 Kcal was significantly higher than the control with 424 Kcal.

For all the other parameters of proximate composition, difference between control sample of fruit *chat* and test sample was found to be statistically significant ($p \leq 0.01\%$). The moisture content of 3.01% was observed in control fruit *chat* while the test fruit *chat* which was prepared from quinoa contain significantly more moisture of 4.02%. Total ash, crude fat and crude fibre of test sample i.e. 3.05%, 5.24% and 3.75% respectively was significantly higher than that of control fruit *chat* in which ash content was 1.61%, crude fat 1.28% and crude fibre 2.19%. The protein content in test fruit *chat* 12.45% was significantly higher than control fruit *chat* 2.85%. This huge difference was due to the more protein content present in quinoa which was added to test sample. The carbohydrate content was observed in control as 89.06% and test fruit *chat* with 71.49%. The energy content of test fruit *chat* with 382 Kcal was significantly higher than the control with 379 Kcal.

Results revealed that the moisture content of control cutlets was 2.62% while the test cutlets contain significantly less moisture of 1.12% than control sample. The protein content in test cutlets 14.14% was found to be significantly higher than control cutlets 9.78%. The ash, crude fat and crude fibre of test sample i.e. 1.12%, 24.16% and 3.45% respectively was significantly higher than that of control cutlets in which ash content was 0.59%, crude fat 22.45% and crude fibre 2.03%.The carbohydrate content was observed in control as 62.53% and test cutlets 56.01% which was significantly lower than the control sample. The energy content of test cutlets with 498 Kcal was significantly higher than the control with 491 Kcal. Kaur (2013) reported that the moisture content of *tikki* ranged from 4.45% for control to 2.60% with substitution of fresh potatoes with potato flour in acceptable level S_1 (30%). The protein content was found 6.78% for control as compared to S_1, fat content ranged from 13.78% for control as compared to 14.51% for acceptable level S_1. The fibre content of *tikki* ranged between 2.72% for control to 3.38% for S_1. Lakra and Sehgal (2011) developed cutlet using potato flour, defatted soy flour: corn flour blending ratio 60:25:15 reported 18.2g protein, 5.2g ash and fat 19.2g/100g.

Table 2. Proximate composition of developed products using quinoa grain (on dry weight basis)

Products	Moisture (%)	Crude protein (%)	Crude fat (%)	Total ash (%)	Crude fibre (%)	Carbo-hydrate (%)	Energy (Kcal)
Sweet porridge							
C	4.66±0.05	15.65±0.05	24.00±0.58	1.15±0.06	1.63±0.06	52.81±0.58	490
S_1	2.66±0.06	19.40±0.06	29.00±0.57	2.20±0.05	2.28±0.05	44.46±0.06	516
t-value	24.50**	47.04**	6.12**	12.86**	7.96**	14.39**	45.16**
Vegetable porridge							
C	2.88±0.06	11.75±0.05	10.43±0.06	2.20±0.06	1.77±0.06	70.97±0.06	424
S_1	1.92±0.05	14.65±0.06	12.07±0.01	2.40±0.05	2.96±0.05	66.00±0.58	448
t-value	11.76**	35.52**	28.27**	2.45*	13.87**	8.57**	3.34*
Fruit *chat*							
C	3.01±0 .01	2.85±0.05	1.28±0.06	1.61±0.06	2.19±0.01	89.06±0.04	379
S_1	4.02±0.01	12.45±0.06	5.24±0.05	3.05±0.01	3.75±0.06	71.49±0.04	382
t-value	123.70**	117.58**	48.50**	24.82**	26.89**	21.52**	4.62**
Cutlets							
C	2.62±0.01	9.78±0.06	22.45±0.06	0.59±0.06	2.03±0.01	62.53±0.06	491
S_1	1.12±0.06	14.14±0.06	24.16±0.06	1.12±0.06	3.45±0.06	56.01±0.58	498
t-value	25.85**	53.40**	20.94**	6.49**	24.47**	11.24**	11.65**

Values are Mean±S.E, *Significant at 5% level, **Significant at 1% level

DETERMINATION OF AMINO ACID CONTENT OF QUINOA GRAIN PRODUCTS

The amino acid content of products developed from quinoa grain has been given in the Table 3. The amino acid content namely lysine, methionine and tryptophan of the test (S_1) and control sample (C) of sweet porridge showed that the lysine content of 14.25g/100g protein was observed in control sweet porridge while the test quinoa sweet porridge contain significantly more lysine of 19.78g/100g protein. The tryptophan and methionine content of test sweet porridge was observed to be 3.51g/100g protein and 6.90 g/100g protein respectively which is significantly higher than the control sweet porridge i.e. 2.61 g/100g protein and 4.40 g/100g protein respectively.

The results for vegetable porridge revealed that the test vegetable porridge (S_1) contain lysine content of 8.15g/100g protein which was significantly higher than the control vegetable porridge (C) that had lysine content of 4.90g/100g protein. The tryptophan and methionine content of test vegetable porridge i.e. 1.10g/100g protein and 2.2g/100g protein respectively was observed to be significantly higher than the control vegetable porridge i.e. 0.79g/100g protein and 0.18g/100g protein respectively.

The amino acid content namely lysine, methionine and tryptophan of the test (S_1) and control sample (C) of fruit *chat* revealed that the lysine content of 8.80g/100g protein was observed in control fruit *chat* while the test quinoa fruit *chat* contain significantly more lysine of 13.40g/100g protein. The tryptophan content of test fruit *chat* was observed to be 2.84g/100g protein that is significantly higher than the control fruit *chat* i.e. 2.02 g/100g protein. The methionine content of test fruit *chat* to be 4.18g/100g protein which is significantly higher than the control fruit *chat* i.e. 2.01g/100g protein.. The lysine content of 8.15g/100g protein was observed in control cutlets while the test cutlets contain significantly more lysine of 11.45g/100g protein. The tryptophan and methionine content of test cutlets was observed to be 0.90g/100g protein and 0.90g/100g protein respectively which was found to be significantly higher than the control cutlets i.e. 0.65g/100g protein and 0.52g /100g protein respectively.

Table 3 Amino acid content of developed products using quinoa grain (g/100g protein on dry weight basis)

Products	Lysine (g/100g protein)	Tryptophan (g/100g protein)	Methionine (g/100g protein)
Sweet porridge			
C	14.25±0.05	2.61±0.06	4.40±0.05
S_1	19.78±0.06	3.51±0.05	6.90±0.06
t-value	67.73**	11.02**	30.62**
Vegetable porridge			
C	4.90±0.06	0.79±0.05	0.18±0.01
S_1	8.15±0.01	1.10±0.06	2.2±0.06
t-value	56.01**	3.80*	34.81**
Fruit *chat*			
C	8.80±0.06	2.02±0.04	2.01±0.01
S_1	13.40±0.05	2.84±0.06	4.18±0.06
t-value	56.34**	12.13**	37.40**
Cutlets			
C	8.15±0.01	0.65±0.01	0.52±0.01
S_1	11.45±0.06	0.90±0.06	0.90±0.06
t-value	56.87**	4.31*	6.89**

Values are Mean±SE; *Significant at 5% level; **Significant at 1% level

DETERMINATION OF MINERAL CONTENT OF QUINOA GRAIN PRODUCTS

The mineral content of the control sample (C) of sweet porridge developed from broken wheat and test sample (S_1) developed from quinoa is given in the Fig 1. The calcium content of 214 mg was observed in control sweet porridge while the test sweet porridge contain significantly higher calcium content of 248.50 mg because of the quinoa in the test sample. The iron content in test sweet porridge 5.34 mg was significantly higher than control sweet porridge which contains iron of 2.48 mg Fig 2. The magnesium content of test sweet porridge 283 mg was significantly higher than the magnesium content of control 98 mg. The zinc content of test sweet porridge was 4.26 mg which was significantly higher than the control sweet porridge i.e. 1.03 mg. The calcium content of 42 mg was observed in control vegetable porridge while the test vegetable porridge contains significantly higher calcium content of 69.80 mg. The iron content in test vegetable porridge 4.41 mg was significantly higher than control vegetable porridge 3.42 mg. The magnesium content of test vegetable porridge 114.20 mg was significantly higher than the magnesium content of control 13.62 mg. The zinc content of test vegetable porridge with 2.1 mg was significantly higher than the control with 0.05 mg. Farzana *et al* (2003) found that *maida* (refined wheat flour) contain 2.1 mg iron per 100g where as wheat flour 7.1mg of iron per 100g. Gopalan *et al* (2007) reported iron in whole

wheat flour, refined wheat flour and rice flakes as 4.9, 2.7 and 20 mg/100g.

The calcium content of 80 mg was observed in control fruit *chat* while the test fruit *chat* contain significantly higher calcium content of 130 mg which is due to the addition of quinoa along fruits in test sample. The iron content in test fruit *chat* 4.6 mg was significantly higher than control fruit *chat* 1.50 mg. The magnesium and zinc content of test fruit *chat* 195 mg and 3.20 mg respectively which was found to be significantly higher than the control 65 mg and 0.22 mg respectively. The calcium content of 60 mg was observed in control cutlets while the test cutlets contain significantly higher calcium content of 94 mg which is due to the addition of quinoa in test sample. The iron content in test cutlet 1.54 mg was significantly higher than control cutlets which contain iron content of 0.93 mg. The magnesium and zinc content of test cutlets was 62.20 mg and 1.11 mg respectively which was found to be significantly higher than the control 30.45 mg and 0.48 mg respectively. Kumari *et al* (2014) had prepared the value added product namely cutlets by incorporating amaranth seeds at 30 percent, 40 percent and 50 percent level refers as T_1, T_2, T_3 respectively and the control T_0 without the incorporation of puffed amaranth seeds.. It showed that the T_1 cutlet range of nutrient for iron 1.49-8.8 mg and calcium ranged between 17.8-144.8 mg per 100g. The same was reported by Nazni and Pradheepa, (2010) and Nazni and Shalini (2010).

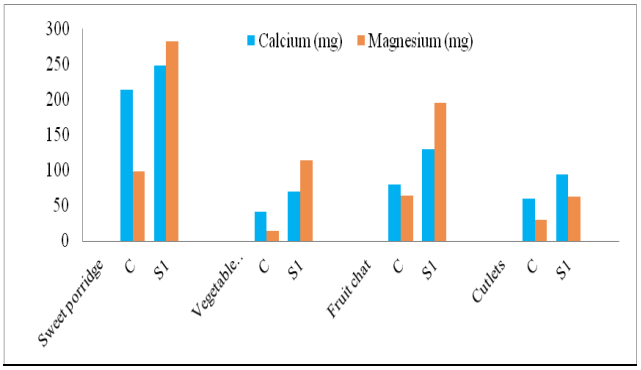

Fig 1: Calcium and magnesium content of developed products using quinoa grain (mg/100g on dry weight basis)

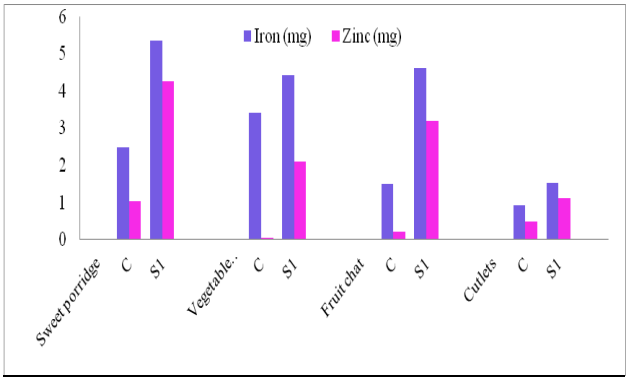

Fig2: Iron and zinc content of developed products using quinoa grain (mg/100g on dry weight basis)

FIBRE FRACTIONS OF DEVELOPED PRODUCTS USING QUINOA GRAIN

Data on the fibre fractions of various food products prepared from quinoa grain have been presented in the Fig 3. The values are on dry weight basis.

The neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of sweet porridge revealed that the NDF content of test sweet porridge 36.80% was significantly higher than the content in control sweet porridge i.e. 20.86%. Singh (2007) reported the neutral detergent fibre content i.e. 5.90 in wheat based recipes and 5.98 in pearl millet based recipes. The ADF content in the test sweet porridge was 19.20% which was found to be significantly higher than control sweet porridge (16.40%). Sharma (2009) reported that the NDF value of control sweet *dalia w*as 16.4% while supplementation of oats at 25% level increased it to 17.7% and ADF value for test sweet *dalia* was 4.1% while control sample had lower value of 3.1%. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) content of vegetable porridge given in the table 4.25 revealed that the NDF value of test vegetable porridge 60.30% which was non-significantly higher than control vegetable porridge i.e. 58.80%. The acid detergent fibre content in test vegetable porridge was 28.80% which was significantly higher than control vegetable porridge (24.80%). Sharma (2009) reported that the NDF value of control salty *dalia* was 17.2% while supplementation of oats at 25% level increased it to 18.8% and ADF value for test salty *dalia* was 3.7% while control sample had lower value of 2.9%.

The neutral detergent fibre and acid detergent fibre content of fruit *chat* (% on dry weight basis) revealed that the NDF content of test fruit *chat* 74.70% which was significantly higher than control fruit *chat* i.e. 65.20%. However, non-significant difference was found in the ADF value of test fruit *chat* (26%) and the control fruit *chat* (25.00%). The neutral detergent fibre and acid detergent fibre content of cutlets (% on dry weight basis) given in the table 4.25 revealed that the NDF content of test cutlets 70.50% which was significantly higher than control cutlets i.e. 60.30%. The acid detergent fibre content in test cutlets (27.00%) was significantly higher than control cutlets (25.30%).

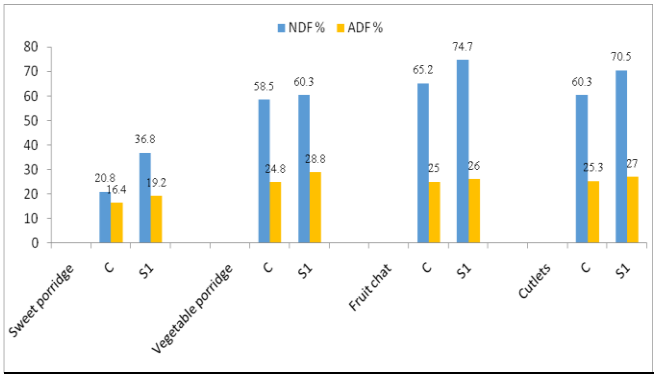

Fig 3: Neutral detergent fibre (NDF) and acid detergent fibre (ADF) of products prepared using quinoa grain (% on dry weight basis)

CONCLUSION

Products namely vegetable porridge, sweet porridge, fruit *chat* and cutlets developed by using quinoa were organoleptically highly acceptable. The recipes developed by using quinoa grain were found to have higher proximate, mineral content and fibre fractions as compared to the control recipes. Quinoa based recipes contain a balanced set of amino acid content as compared to control recipes. Lysine which is a limiting amino acid in cereals, have significant higher values ranging from 11.45-19.78g/100 protein among the developed products. Quinoa's highly proteinaceous grain containing balanced set of amino acids can be recommended to celiac patients. Quinoa grain can be utilized like the other cereal grains for the development of products.

REFERENCES

- AOAC. American society of analytical chemistry and preparation method. 2000; 999:10.
- Barka, K. M., Suraini, A. D. and Manap, P. Y. A nutritious porridge prepared from supplementing rice. J Nutr 2004; 14:183-93.
- Carpenter, K. J. The estimation of available lysine in animal protein foods. J Biochem.1960; 77:604 - 10.
- Concon, J.M. Rapid and simple method for determination of tryptophan in cereal grains. Anal Biochem. 1975; 67:206.
- Drzewiecki J, Delgado-Licon E, Haruenkit R, Pawelzik E, Martin- Belloso O and Park Y S. Identification and differences of total proteins and their soluble fractions in some pseudocereals based on electrophoretic patterns. J Agri Food Chem. 2003; 51:7798-804.
- Edema M O, Sanni P L and Abiodun K S. Organoleptic and nutritional evaluation of soya porridge. Afr J Biotech. 2005; 9: 911-18.
- Farzana C, Deshpande B and Begum M. Nutritional components of wheat products. Ind J Nutr Dietet. 2003; 40:141.
- Flander Z K, Olaival C E and Harvy Q G. Development and nutritional evaluation of oat products. Scand J Food Sci Tech. 2007; 20: 187-99.
- Georing H K and Van Soest PJ. Forage fibre analysis (Apparatus reagents, procedure and some other applications), U.S. Department Agric. 1970 Agricultural Handbook Series No.379.
- Gopalan C, Ramashastri B V and Balasubramanian S C. Nutritive values of Indian foods. National Institute of Nutrition, ICMR, Hyderabad 1989.
- Horn J M, Jones D B and Blum A E. Colorimetric determination of methionine in proteins and foods. J BiolChem. 1946; 166:313- 20.
- Kaur. Development of value added products using potato flour for nutritional and health benefits. M.Sc. thesis, Punjab Agricultural University, Ludhiana, Punjab, India. 2013.
- Khetarpaul N, Goyal R and Garg R. Nutritional and sensory evaluation of nutritious porridge prepared using combinations of soy and sorghum grits. Nutr and health. 2004; 17(4): 309-15.
- Kumari Priyanka, Verma Anisha and Neeru Bala. Utilization of Amaranth seeds (Amaranth Caudatus) for the Development of Micro-nutrients Rich Gluten Free Recipes. Ethelind School of Home Science, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad, India.2014.
- Lakra and Sehgal. Influence of processing on total and extractable mineral content of products prepared from potato flour. J Food Sci Tech. 2011; 48:735-39.
- Loverday S M, Hindmarsh J P, Creamer L K and Singh H. Physicochemical changes in a model protein bar during storage. Food Res Int. 2009; 42(7): 798-806.
- Mandge H M, Sharma S and Dar B N (2014) Instant multigrain porridge: effect of cooking treatment on physicochemical and functional properties. J Food Sci Tech. 2014; 51(1): 97-103.
- Nazni, P and Pradheepa,S Physico-Chemical analysis and organoleptic evaluation of papads prepared from Jowar millet flour, International Journal of Current Research, Vol. 3, pp. 033-037. ISSN: 0975-833X (2010)
- Nazni, P, and Shalini, S Standardization and Quality Evaluation of Idli Prepared From Pearl Millet (Pennisetum glaucum) International Journal of Current Research, Vol. 5, pp.084-087. (2010) ISSN: 0975-833X
- Repo-C R, Espinoza C and Jacobsen S E (2003) Nutritional value and use of the Andean crops quinoa (*Chenopodium quinoa*) and ka˜niwa (*Chenopodium pallidicaule*). Food Rev Int. 2003; 19 (1–2):179–89.
- Sharma and Chawla. Organoleptic and nutritional evaluation of fibe rich products from oats. M.Sc. thesis, Punjab Agricultural University, Ludhiana, Punjab, India.2009.
- Sharma K D, Bindal G, Rathour R, Rana J C. β-Carotene and mineral content of different Chenopodium species and the effect of cooking on micronutrient retention. Int J Food Sci Nutr. 2012; 63(3):290-95.
- Singh. Development and nutritional evaluation of supplementary foods prepared from pearl millet (*pennisetum glaucum* (L.) R.Br.) . M.Sc. thesis, Punjab Agricultural University, Ludhiana, Punjab, India.2007.