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Quality assessment of vermicelli prepared from quinoa and prophylactic moringa leaves

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Abstract
The use of nutritious food grains or other raw materials into traditional food products is highly appreciable in the field of food science and technology. Quinoa is considered as a nutritious gluten-free grain with rising demand worldwide, while Moringa leaves has been recognized as a source of various nutritional and medicinal benefits. This paper elaborates on the properties of 'low gluten vermicelli' fortified with quinoa and moringa leaf powder.

Based on the results of all the experiments, the usage of quinoa was suitable up to 60% for preparation of palatable, nutritional and low gluten vermicelli. While additional 1g powdered moringa leaves per 100g of quinoa and refined wheat flour mixture played an important role in enhancing nutritional values of the prepared vermicelli. The developed vermicelli was superior in nutritional quality compared to refined wheat flour vermicelli as it was higher in terms of protein, fiber, Ca and Fe. It provides a better, healthy and convenient alternative to the consumers especially celiac patients as gluten content decreased from 7.21% (in 100% refined wheat flour combination) to 2.8% in combination which contained 60% quinoa and 40% refined wheat flour.

Keywords: Cold extrusion, moringa, quinoa, tragacanth gum, vermicelli

Introduction

Cold extrusion is a method in which the food temperature remains atmospheric and is used for the combining and sculpting of foods such as pasta and other shaped food products. Low temperature extrusion is often used to develop pasta, vermicelli at temperatures within 100 °C (Wang *et al.*, 1994) [32]. Its positives are its low cost, sustainability and versatility for the processing of a wide variety of food items. Bioactive compounds are added to the basic mixtures for the formulation of functional foods, the main sources being cereals, legumes and other nutrient-rich foods (Martha *et al.*, 2017) [17]. The word "extrude" is derived from the Latin word "ex"-out and "trude"-to be pushed (Kehinde Adedeji Adekola, 2016) [15].

Quinoa (*Chenopodium quinoa*) is considered as a pseudo-cereal and its demand is increasing gradually everywhere in the world. It has outstanding nutritional qualities and is considered as a super-food, as it contains considerable amount of protein, vitamins (especially Vitamin E) and can provide heart-healthy fats like MUFA, omega-3 fatty acid, α- linolenic acid (Bhargava *et al.*, 2006) [8]. In addition, considering the lack of gluten, it is ideal for celiac patients.

Moringa oleifera has been identified as a plant with numerous benefits including nutritional and medicinal purposes. It comprises essential amino acids, carotenoids, important antioxidants, antibiotics, vitamins, minerals and nutraceutical components that encourage the concept of using this plant as a dietary supplement or as a food preparation part (Razis *et al.*, 2014) [27].

Gluten is a protein found in cereals like wheat, rye, barley etc. and is responsible for chewiness, softness and other texture characteristics. The gluten protein triggers an immunological reaction in some gluten-sensitive people. Gluten-free and low gluten diets are becoming increasingly popular, especially due to the growing awareness surrounding gluten intolerance. To retain the physical-sensory properties of gluten-free cereal-based products, several non-gluten cereals and starches (rice, maize, quinoa, sorghum, millets, and potato/pea starch) and various gluten replacers (xanthan and guar gum) have been used. Tragacanth gum was incorporated due to addition of quinoa, gluten which helps in binding of particles together was reduced. The aim of this study is to formulate low gluten vermicelli and to highlight the importance of human consumption of quinoa and moringa leaf and to emphasize their contribution as functional food in diets.

Materials and Methods

The study was carried out in Dept. of food science and technology, College of agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

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Preparation of raw materials

Quinoa was turned into flour by grinding in a hammer mill. In order to minimize the color and nutrient losses, moringa leaves were washed, shade dried and ground into a fine powder. Samples of various formulations were prepared by adding the pre-calculated quantity of flour as stated in table 1. For the vermicelli preparation, utensils and accessories made of food grade stainless steel (SS 304) were used.

Preparation of vermicelli

The prepared dough was fed to the household single-screw extruder feeder under pre-set operating conditions. When the vermicelli came out of the extruder, they were collected in the trays. Collected vermicelli was dried, wrapped and packaged in various packing materials. Prepared extrudates were further studied in compliance with the criteria of this study.

Table 1: Formulation of vermicelli fortified with quinoa and powdered moringa leaves

Samples	Quinoa (g)	Refined wheat flour (g)
V1(control)	0	100
V2	20	80
V3	40	60
V4	60	40
V5	80	20
V6	100	0

Other ingredients used in combinations (other than control)

Moringa leaf powder: 1g, Edible oil: 2ml, Tragacanth gum: 1g

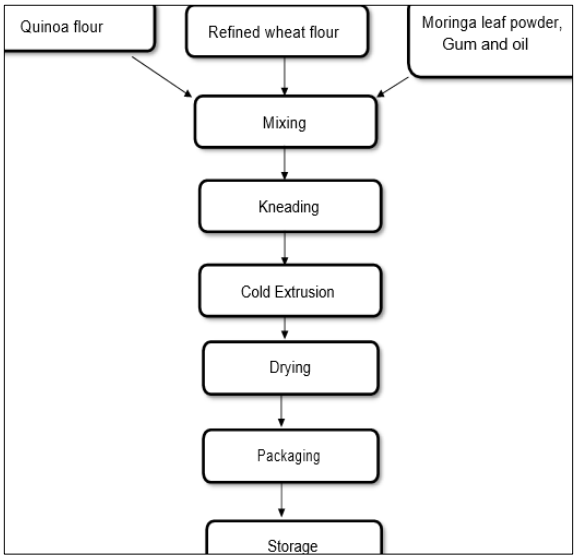

Fig 1: Flow chart for preparation of vermicelli

Sensory evaluation

Sensory evaluation of all the samples was done using 9 point hedonic scale with the help of 15 trained panelists. The parameters which were considered main for the sensory analysis were color and appearance, taste, texture, flavor, overall acceptability.

Biochemical analysis

Biochemical analysis was done for moisture, protein, fat, crude fibre, ash and gluten content for raw materials and the formulated product. The total carbohydrate was determined by the difference (FAO, 1998) [10]. The vermicelli was also subjected to iron, calcium, phosphorus and magnesium content determination. For all of the above determinations, the standard procedures provided by Ranganna (1986) [26] were used. Energy value was calculated by value substitution method (Atwater and woods, 1896).

Statistical analysis

Entire analysis was performed in triplicate. The analytical data obtained for low gluten quinoa vermicelli was subjected to analysis using complete randomized design (Panse and Sukhatme, 1984) [25].

Results and Discussion

Sensory evaluation: Sensory evaluation chart was provided to the panelists, which contained hedonic ratings. The results of sensory evaluation depicted that V4 (containing 60% quinoa) was found to give best results as per the overall acceptability as can be seen from table 5 and Figure 4.

Table 2: sensory evaluation of vermicelli fortified with quinoa and Moringa

Treatments	Color and appearance	Taste	Texture	Flavor	Overall acceptability
V1	8.89	8.64	8.82	8.2	8.64
V2	8.12	8.34	8.47	8.23	8.29
V3	8.16	8.48	8.21	8.31	8.26
V4	8.23	8.60	8.13	8.56	8.40
V5	8.02	7.86	7.77	8.06	7.93
V6	7.21	7.68	7.63	7.18	7.43
SEM	0.025	0.273	0.283	0.076	0.174
CD @ 5%	0.146	0.139	0.099	0.394	0.401

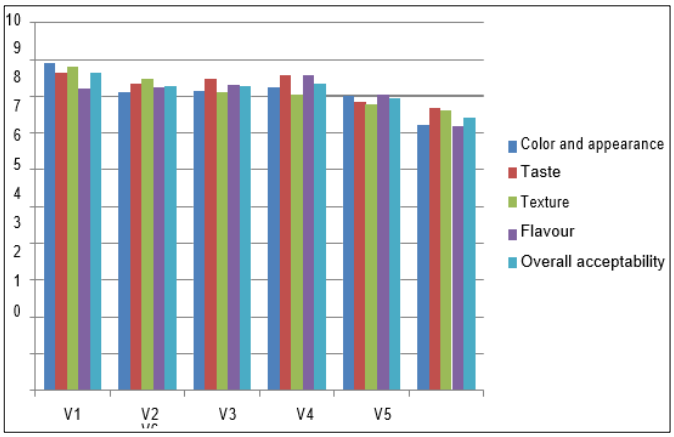

Fig 2: Sensory evaluation of vermicelli fortified with quinoa and Moringa

Biochemical analysis

As per the analysis, increment in protein, ash and fat was noticed whereas the carbohydrate content proportionately decreased with modification. This is due to increased proportion of moringa which is higher in protein and ash content with lower carbohydrate content. Similarly, quinoa also increased the fat content in the vermicelli samples. Arise *et al*. (2014) [2] and Olorode *et al*. (2013) [24] found that the addition of moringa leaf powder substantially improve the

nutritional value of their experimental product. Falowo *et al.* (2017) [9] has suggested that the fortification of refined foods with *M. Oleifera* has been reported to improve nutritional benefit, certain organoleptic properties, oxidative stability and shelf life of the product. Stikic *et al.* (2012) [29] reported the similar finding with regards to protein enhancement through supplementation by quinoa. Navruz and Sanlier (2016) [28] stated quinoa's superiority over other grains results from its richer protein, lipid and ash content in the product in which it is used. Carbohydrate of all the formulated samples decreased because both the quinoa and moringa leaf powder possess lower percentage of carbohydrate in comparison to wheat. An addition of constant amount of moringa leaf powder in samples also led to decrement in carbohydrate content when compared to control which didn't have MLP at all. Arise *et al.* (2014) [2] made similar observations.

The energy value of the product is directly related to its protein, fat and carbohydrate content. The energy value of sample V6 (containing 100g quinoa) was found to be the maximum in contrast to the control V1 which had the minimum value. The energy value of vermicelli increased as the percentage of quinoa increased among the samples. Mogra and Midha (2013) [19]; and Karpagavalli and Amutha (2015) [1] stated in their research that the energy content of the samples increased on incorporation of non-wheat raw materials like sago, spinach, green gram and other cereal pulse blends to the traditional vermicelli which encourages the incorporation of moringa leaf powder for product formulation. The fiber content of vermicelli samples V2 (containing 20g quinoa) to V6(containing 100g quinoa) were greater than control and kept on increasing as quinoa content increased. The high amount of fiber content of Moringa Leaf Powder also contributed to increment of fiber content. Similar results were reported by Gonzalez *et al.*, (2014) [13], Fardet (2010) [11] and Lamothe *et al.* (2015) [16] as quinoa is an excellent source of dietary fiber, comprising about 2.6%-10% of the total weight of the grain.

Gluten content reduced from 7.2% to 0% in V1 (containing 0g Quinoa) to V6 (containing 100g Quinoa) as the quinoa flour increased. Vermicelli of the combination V4 (containing 60g Quinoa) which was best according to sensory evaluation contained 2.87% gluten. Decrement of gluten content in formulated vermicelli was important for celiac patients as Gil *et al.*, (2014) [12] also described that low gluten bread formulated by them represents a great advance in the development of food safe for people around the world suffering gluten-related pathologies, with excellent organoleptic properties and greater nutritional quality. The results presented by them indicate that flour and bread with reduced levels of gluten would be safer for gluten intolerant consumers. Azizi *et al.*, (2020) [7] substituted Refined Wheat Flour by quinoa flour at various percentages for the formulation of low gluten bread and were reportedly successful. Michelle (2000) concluded that the sorghum noodles produced in their experiment indicated that grains other than wheat could also be used to produce a non- wheat noodle as wheat flour cannot be tolerated by those who suffer allergies to gluten.

Minerals

The results of mineral estimation clearly depicted significant increase in mineral values of samples in comparison to control. Content of all the minerals *viz.* Ca, Mg, Fe and Zn increased manifolds. This can be due to MLP and quinoa supplementation and their contribution to the increment in mineral value; the same was reported by Vega Galvez *et al.*, (2010) [30]. Studies have shown that the moringa leaves have immense mineral value (Arise *et al.*, 2014; Anjorin *et al.*, 2010 and Wakil and Kazeem, 2012) [2, 1, 31] addition of which enhanced the mineral content of vermicelli. Mineral content of the samples increased as the amount of quinoa increased. Its calcium and iron content is higher than that of other commonly used grains (Varli and Sanlier, 2016) [28] and usage of these grains along with MLP significantly increased the mineral content of produced vermicelli.

Table 3: Biochemical analysis of raw materials used in various vermicelli combinations

Parameters	Quinoa	MLP	RWF
Protein (%)	15.76	25	12.45
Fat (%)	6.23	2.7	1.62
Ash (%)	1.99	8.85	1.58
Moisture (%)	9.2	6.3	11.53
Carbohydrate (%)	66.82	57.15	72.82
Fiber (%)	4.46	9.84	1.85
Gluten (%)	--	--	7.2
Ca (mg/100g)	139.2	1431.7	22.03
Mg (mg/100g)	250.42	196.07	124.58
Fe (mg/100g)	14.2	27.42	4.2
Zn (mg/100g)	4189	238.47	860

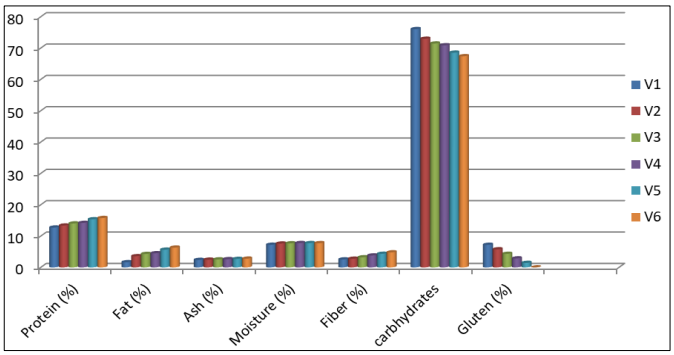

Fig 3: Biochemical analysis of vermicelli fortified with quinoa and Moringa

Table 4: Biochemical analysis of vermicelli fortified with quinoa and Moringa

Parameters	V1	V2	V3	V4	V5	V6	SEM	CD @ 5%
Protein (%)	12.72	13.36	14.024	14.2	15.35	15.76	0.084	0.267
Fat (%)	1.65	3.57	4.29	4.51	5.65	6.31	0.078	0.276
Ash (%)	2.39	2.47	2.55	2.63	2.71	2.79	0.069	0.264
Moisture (%)	7.22	7.62	7.681	7.771	7.752	7.73	0.182	0.384
Carbohydrates (%)	76.04	72.97	71.45	70.88	68.53	67.39	0.251	0.087
Fiber (%)	2.54	2.76	3.22	3.81	4.33	4.8	0.117	0.157
Energy value (Kcal/100 g)	369.89	377.45	380.52	380.92	386.91	389.43	0.072	0.171
Gluten (%)	7.2	5.77	4.32	2.87	1.44	0	0.184	0.426

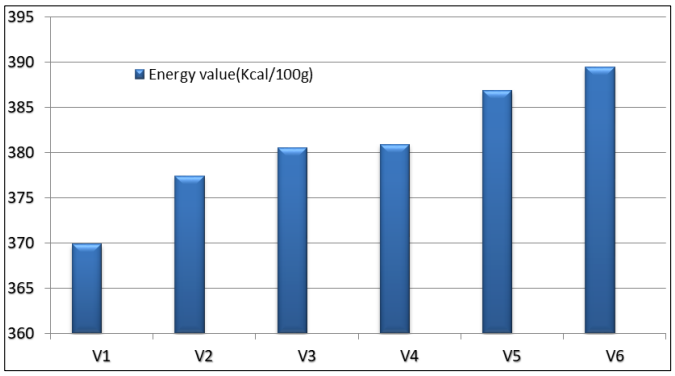

Fig 4: Energy value of vermicelli fortified with quinoa and Moringa

Table 5: Mineral content of vermicelli fortified with quinoa and Moringa

Sample	Ca (mg/100 g)	Mg (mg/100 g)	Fe (mg/100 g)	Zn (mg/100 g)
V1	24.54	125.92	3.831	869
V2	56.76	151.6	6.714	1528.18
V3	83.2	176.86	8.493	2219.2
V4	106.64	202.04	10.199	2858
V5	130.06	227.2	12.735	3525.58
V6	153.52	252.38	14.608	4191.38
SEM	0.023	0.051	0.313	0.364
CD @ 5%	0.391	0.201	0.293	0.068

Conclusion

An attempt was made to formulate and assess low gluten vermicelli using quinoa and powdered moringa leaves. On the basis of the findings, it is concluded that up to 60% of the use of quinoa was found to be suitable for the preparation of palatable, nutritious and low gluten vermicelli. Although an additional 1 gram of powdered moringa leaves per 100 g of quinoa and refined wheat flour mixture played an important role in improving the nutritional qualities and colour enhancement of the prepared vermicelli. As it was higher in terms of protein, carbohydrate, Ca and Fe, the produced quinoa vermicelli was superior in nutritional efficiency compared to refined wheat flour vermicelli. It offers customers, especially celiac patients a easy substitute, as the gluten content decreased from 7.21 percent to 2.8 percent. The findings of the sensory study also revealed that customers strongly valued the formulated product V4 containing 60 percent quinoa and 40 percent RWF integrated with 1g MLP and 1g tragacanth gum and held for storage along with control.

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