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Utilization of amaranth and quinoa flour to produce some bakery products to autism children

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ABSTRACT

Children with autism spectrum disorders (ASD) and their caregivers face unique challenges in the children's daily eating routines and food intake patterns. Therefore, this study was carried to evaluate some bakery products as biscuit and crackers made from germinated quinoa, amaranth flour, potato puree and rice mill free gluten and casein to autism children. Chemical compositions and minerals content were determined in raw materials (germinated quinoa, amaranth flour, potato puree and rice mill) and also, physical characteristics and sensory evaluation were determined in different formulae made from raw materials at different levels. The results reported that the germinated quinoa was the highest in protein (15.23%) followed amaranth flour was 13.50%, meanwhile, crude and total dietary fiber were increased in amaranth flour followed by germinated quinoa. Moreover, the germinated quinoa and amaranth flour are a rich source of phytochemicals. Good amounts of essential minerals were determined in germinated quinoa, amaranth flour, potato puree and rice mill like potassium, sodium, calcium phosphorus, cupper, iron and manganese. The physical properties were determined in different formulae of biscuits and crackers and the results observed that the diameter of biscuits different formulae was found significantly lower than that of control biscuit and the thickness of biscuits slightly increased. The changes were reflected in spread ratio and percent spread of biscuit. Whereas, the results from the physical properties of crackers observed that the variation in these results may be caused the different crackers formulae had contained rich in fiber which absorption high amounts of water this could be increased the weight and decreased in the volume. The results from the sensory evaluation of biscuits and crackers were ensuring the resultant from the physical properties. The biscuits and crackers made from with the rice mill, potato puree, amaranth flour and germinated quinoa indicated very good nutritional properties and mineral content and hence can be considered healthy for consumption. Based on the results presented here it can be concluded that the amaranth flour and germinated quinoa are rich source of bioactive compounds and thus offers several opportunities for the development functional foods and nutraceuticals.

KEY WORDS: Gluten-free and casein-free diet, autism, crackers, biscuits.

INTRODUCTION

Autism spectrum disorder (ASD) is a clinically heterogeneous neurodevelopment disorder that manifests as persistent impairments in social interaction and social communication, with repetitive or stereotyped behaviors that range from mild to severe [1]. Children with ASD typically present with delays in language, such as lack of spoken language or inability to sustain conversation, difficulties with social interaction, such as emotional reciprocity, and have severely restricted behaviors, including inflexible adherence to a specific routine and obsessive like interests [1].

Two of the most common problems in children with ASD are difficult eating behaviors and gastrointestinal (GI) symptoms. As early as 1979, mealtime difficulties, such as increased food selectivity (e.g., picky eating), food refusal, and disruptive mealtime behaviors were reported in as many as 90% of children with ASD [2, 3].

More recently, cross-sectional data from the 2003–2004 National Survey of Children's Health indicate that children with ASD were 40% more likely to be obese [body mass index (BMI)-for-age ≥ 95th percentile] compared to typically developing children (TDC) [4].

Eating and feeding problems, most commonly food selectivity or picky eating, are common among children with Autism Spectrum Disorders ASD. While these behaviors are typically addressed through occupational or behavior-based therapeutic approaches, increasing evidence shows than in many cases, such eating and feeding problems may be organic and stem from some form of underlying gastrointestinal dysfunction [5].

Given the increased risk of adverse health effects and chronic diseases associated with obesity, these data are particularly alarming. The study of eating behaviors and diet quality among children with developmental disabilities, including children with ASD, is an emerging field of research. A small number of studies [6, 7] and anecdotal evidence/case reports suggest that children with ASD are picky eaters and show aversions to certain textures, smells, colors, temperatures, and brand names of foods, all of which can adversely affect diet quality Further, food selectivity in children with ASD may be the result of sensory over responsively to the taste, texture or smell of certain foods [8, 9]. Mealtime difficulties not only put children with ASD at increased risk for nutritional deficiencies, but they also put a strain on parents and caregivers.

Gluten-free starchy materials, such as maize, rice and potato, are usually used in the manufacturing of bread, pasta, biscuits, and textured using different combinations of thickenings (guar gums, carboxymethyl cellulose and carob flour), and particular food processing procedures different from the conventional ones [10]. As a result, many gluten-free cereal foods do not contain the same levels of B-vitamins, iron and fiber as their gluten-containing counterparts [10, 11]. Quinoa is a safe choice for the production of gluten-free products [12, 13]. Unlike most grains, quinoa contains a complete protein. It is high in essential amino acids and fatty acids and it's a good source of vitamin C, E and several of the B vitamins [14]. This makes it especially good as a grain substitute in gluten free diets as most people get the majority of their B vitamins from baked goods. Quinoa contains between14 and 18% protein, with characteristics similar to milk protein. Quinoa is also a source of calcium, magnesium, zinc and iron [15, 16]. A need to improve the nutritional quality of gluten-free cereal foods has been raised by many medical and nutritional experts [17, 18]. The quinoa seed was characterized by an excellent nutrient profile. Besides being important energy sources due to their starch content, quinoa provide good-quality protein, dietary fiber and lipids rich in unsaturated fats [19]. Moreover, they contain adequate levels of important micronutrients, such as minerals and vitamins and significant amounts of other bioactive components, such as saponins, phytosterols, squalene, fagopyritols and polyphenols. In a series of recent studies, the nutritional properties and baking characteristics of amaranth, quinoa and buckwheat have been assessed [19, 20, 21].

Amaranth is a plant which contained antihypertensive, antioxidant and cancer preventive peptides. Also there is evidence that amaranth has some hypoglycemic action; however, the anti-diabetic potential and the effect upon body weight of the seed proteins have not been well characterized [22]. In the last decade, the use of amaranth had broadened not only in the common diet [23]. These pseudo-cereals seeds have high nutritional and functional values which are associated with the quality and quantity of their proteins, fats and antioxidant potential [24, 25, 26]. A new way in nutrition, in recent years, is the consumption of sprouts – the atypical vegetable, which have received attention as functional foods, because of their nutritive value including amino acid, fiber, trace elements and vitamins as well as flavonoids, and phenolic acids [27]. Moreover, Amaranth has become popular among patients with celiac disease because it does not cause allergic reactions in the intestinal mucosa. However, the high prevalence of diabetes mellitus among these patients is well known [28].

No medical nutrition therapy exists for autistic children despite gastrointestinal symptoms being first reported in the early 1970s – chronic diarrhea, excessive gas, abdominal discomfort, abdominal distension, constipation, and food intolerance. Some parents noticing improvement with diet were told that no research exists. Therefore the objective of this study was carried out to nutrient intake from food as dietary supplements to children autism symptoms.

MATERIALS AND METHODS

Materials:

Quinoa seeds (Chenopodium quinoa Willd), Amaranth light seeds (Amaranth hypochondriacus L.), Rice (Oryze sativa L.), and Potato (*Solanumtuberosum* L.) were obtained from w local market**.** All seeds were milled in a Laboratory Mill Junior to give a fine power. All other materials used in making bakery products as sugar powder, skim milk, improver, butter, corn oil, baking powder, baking soda, eggs and vanilla were obtained from local market.

Methods:

Preparation of germinated quinoa flour:

Quinoa seeds were cleaned and washed several times with running tap water (with constant stirring for about 1-2 min) to get rid of the foam, and soaking in water (1:3 w/v) for 30 hours in darkness (Soaking water is renewed during this period).The water was drained off and the wet seeds transferred to moistened cotton layers and allowed to germinate for 36 hours in darkness at room temperature (20-24°C), and watered 3 times during this period. The sprouts of seeds were dried in an air oven at 55°C. The dried sprouts was milled to a fine powder, and then sieved on a100 µm. sieve, as according to Valencia *et al*. [29]. Finegerminated quinoa flour (whole meal) was packaged into polyethylene bags and stored in deep freezer (-18°C) until using.

Preparation of potatoes puree:

Potato were washed then boiled in little water for about 30 min, then hand peeled and pureed in homogenizer for using in the preparing free gluten bakery.

Preparation of crackers:

Crackers were made according to the methods described in Bose and Shams-Ud-Din [30]. The blends and basic formulations used for preparation of control and gluten-free crackers are outline in Table (1).

The pre weighted ingredients were mixed. Fat was added into the dry ingredients. Water was added accurately to form smooth dough, and the resulted dough was left to rest for 5 min. The dough kneaded and rolled to a uniform thickness of 3 mm. The creekers were cut out. Then the creekers were baked at 200ºC for 10-15 minutes and cooled at room temperature for about 1 hr. before sensory evaluation. The control sample was prepared from 100% wheat flour 72% extraction.

Table 1: The ingredients used to crackers free casein and gluten:

Raw materials	Control	Formula (1)	Formula (2)	Formula (3)	Formula (4)	Formula (5)
Wheat flour	100	--	--	--	--	--
Potato puree	--	20	20	20	20	20
Rice mill	--	20	20	20	20	20
Germinated quinoa flour	--	10	20	30	40	50
Amaranth flour	---	50	40	30	20	10

Preparation of biscuits:

Biscuit was made according to the standard procedure for [31].All dry ingredients were mixed together in a dough mixer for 3 minutes, then all liquid ingredients were added to the dry mixture and mixed at low speed for 3 minutes then water added as require to obtained suitable smooth dough, and the resulted dough was left to rest for 5 min then sheeted to 3mm. thickness. Circle pieces cut of dough were formed by using of templates with an outer diameter of 50 mm. The biscuits were baked at 180°C for 12 min, and allowed to cool at room temperature for 1 hr. before sensory evaluation. The control sample was prepared from 100% wheat flour 72% extraction.

Table 2: The ingredients used to biscuits free casein and gluten:

Raw materials	Control	Formula (1)	Formula (2)	Formula (3)	Formula (4)	Formula (5)
Wheat flour	100	--	--	--	--	--
Rice mill	--	10	10	10	10	10
Germinated quinoa flour	--	15	30	45	60	75
Amaranth flour	---	75	60	45	30	15

Chemical analysis:

Protein, ash content, crude fiber and total lipid were determined in germinated quinoa, amaranth flour, potato puree and rice mill according to the methods described by AOAC [32]. Dietary fiber was determined according to the method described by Prosky et al. [33]. Digestible carbohydrates (D.C) were calculated by difference. Minerals content as K, Na, Ca, P, Cu, Fe and Mn were determined by atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in AOAC [32].

Determination of total phenolics content:

The total phenolics content of the extracts were determined using the method reported by Xu and Chang [34]. A sample of methanolic extract (0.2 ml) was mixed with 1 ml of Folin– Ciocalteau reagent (ten folds dilution). The mixture was allowed to stand for 5 min at room temperature before adding 0.80 ml of 20% Na2CO3 and then mixed gently. The reaction mixture was incubated for 40 min and the absorbance measured at 760 nm in spectrophotometer. The total phenolic content was calculated using gallic acid as standard.

Determination of total flavonoids content:

The total flavonoids content was measured using the Aluminium chloride colorimetric method modified from the procedure reported by Woisky and Salatino [35]. Two ml of the extract was mixed with 100µl of 10 percent AlCl3, 100µl of 1 mol per liter potassium acetate and 2.8 ml water and allowed to incubate at room temperature for 30 min. Thereafter, the absorbance of the reaction mixture was subsequently measured at 415 nm. The total flavonoids compounds were calculated using queractin as standard.

Physical properties of crackers and biscuits and their formulae:

Physical properties of crackers, biscuits and their formulae were determined according to AACC [36].Volume (Cm^3) of produced samples were determined by the displacement of rape seeds, specific volume was calculated as the ratio between the volume of the cooled baked biscuit, high and their weight were determined in crackers and its formulae.

Biscuit diameter (D) and thickness (T) were measured for groups of 10 biscuit. The spread ratio obtained was the ratio between diameter (D) and thickness (T). Volume (Cm^3), specific volume and their weight were determined in biscuit and its formulae.

Sensory evaluation:

Crackers and biscuits produced using suggested blends were evaluated for their sensory characteristics by ten panelists. The scoring scheme was established as described in [36].

Statistical analysis:

The obtained data were exposed to analysis of variance. Duncan's multiple range tests at ($P \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System [37].

RESULTS AND DISCUSSION

Chemical composition and phytochemical analysis of raw materials:

Autism is a complex psychiatric disorder characterized by three core symptoms, i.e. impairments in social interaction, restricted patterns of behavior and impairments in communication. Therefore this study was carried out to evaluate bakery products such as crackers and biscuits free gluten and casein for children with autism disease was made from amaranth and germinated quinoa. Many formulae were prepared from germinated quinoa, amaranth, potato and rice to give many formulae to nutrient intake for children autism.

Chemical composition and phytochemical were determined in germinated quinoa flour, amaranths flour, rice mill and potato puree and the results are tabulated in Table (3). From the resultant it could be noticed that the germinated quinoa and amaranth flour were the highest in protein, ash, total lipid and crude fiber (15.23, 3.79, 3.99 and 7.89 g/100g) in germinated quinoa whereas amaranth flour was 13.50, 5.70, 4.0 and 10.80 g/100g, respectively. Moreover, the potato puree and rice mill were the highest in total carbohydrates 88.49 and 86.55 g/100g dry weight.

The amaranth flour and germinated quinoa were the highest in total dietary fiber, soluble and insoluble dietary fiber 14.35, 2.78 and 11.57 g/100g in amaranth flour and in germinated quinoa was 12.99, 3.85 and 9.14 g/100g, respectively.

The Amaranth is gluten-free and hence easy to digest. The Amaranth grain is 90% digestible and because of its ease of digestion, it has traditionally been given to those recovering from illness or fasting period [38]. A seed of grain amaranth is on average composed of 13.1 to 21.0% of crude protein; 5.6 to 10.9% of crude fat; 48 to 69% of starch; 3.1 to 5.0% (14.2%) of dietary fiber and 2.5 to 4.4% of ash [39]. It is a terrific source of minerals like calcium, magnesium, and copper, a good source of zinc, potassium, and phosphorus. It helps to build strong bones and a muscle, aid hydration, boost energy, and is vital in thousands of processes [40].

Quinoa is potential sources of food due to their high quality of proteins [41]. The amount of high-protein possessing an attractive amino acid balance for human nutrition because of it high levels of lysine and methionine represents a compromise between nutritional improvement and achievement of satisfactory sensory and functional properties of the product. The main problem in the use of quinoa as components, replacing wheat in the blends, arises from the fact that these pseudo-cereals do not contain gluten, and thus the addition into leavened and pasta products are limited [42].

The phytochemical analysis of the amaranth flour was carried out and it was observed that the germinated quinoa and amaranth flour are a rich source of phytochemicals and the resultant are reported in Table (3). The Phytochemicals are biologically active compounds which provide health benefits and hence very attractive in the food industry. The Total phenolics content of the germinated quinoa and amaranth flour were 328.0 and 185.0 GAE equivalents (mg GAE/100g) followed by rice mill and potato puree were 82.1 and 78.23 GAE equivalents (mg GAE/100g), respectively. The Total Flavonoids content of the reconstituted extract was

estimated by the Aluminium chloride method and the results were expressed in mg of queractin equivalents per m100g of dry weight of the extract based on the calibration curve of the standard. The total flavonoids compound in the germinated quinoa and amaranth flour was estimated to be 197.0 and 146.0 mg of queractin equivalents per 100g followed by rice mill and potato puree were 64.54 and 59.46 mg of queractin equivalents per 100g, respectively.

Table 3: Chemical composition of raw materials:

Chemical analysis	Germinated quinoa flour	Potato puree	Amaranth flour	Rice mill
Protein	15.23	7.59	13.50	7.04
Ash	3.79	0.49	5.70	4.59
Lipids	3.99	0.44	4.00	0.97
Crude fiber	7.89	6.99	10.80	7.85
TC	69.10	84.49	66.00	79.55
TDF	12.99	2.10	14.35	5.21
TSDF	3.85	0.40	4.78	1.74
TIDF	9.14	1.70	9.57	3.47
*T. Phenolics	328.0	78.23	185.0	82.21
**T. Flavonoids	197.0	59.46	146.0	64.54

TC: Total carbohydrates TDF: Total dietary fiber
TSDF: Total soluble dietary fiber TIDF: Total insoluble dietary fiber
*Total phenolics as mg gallic acid equivalent/100g dry weight
**Total flavonoids as mg queractin equivalent/100g dry weight

Minerals content of raw materials:

Minerals content as K, Na, Ca, P, Cu, Fe and Mn were determined in germinated quinoa, amaranth flour, potato puree and rice mil and the results are reported in Table (4). The results showed that the potassium was the highest in potato puree and quinoa (955 and 826.7 mg/100g) followed by amaranth flour and rice mill were 326.7 and 320.0 mg/100g, respectively. Sodium is a good source in potato puree, rice mill and germinated quinoa (120.0, 69.0 and 63.0mg/100g) respectively. Furthermore, taken into consideration that potassium depresses while sodium enhances blood pressure, thus, high amount could be an important factor in presentation of hypertension [43]. Moreover, nutritional deficiencies may also play a major role in autism. Significantly lower levels of nutrients in blood, hair, and other tissues have been seen in autistic children including low levels of magnesium [44], zinc [45], selenium [45], vitamins A, B-complex, D, and E [45]., omega-3 fatty acids [46] and carnitine [47].

Calcium was the highest in amaranth mill and rice mill (190.7 and 133.0 mg/100g) followed by germinated quinoa and potato puree were 108.12 and 88.0 mg/100g, respectively. Cupper and iron were the lowest amounted in raw materials. Calcium and phosphorous are associated with each other for development and proper functioning of bone, teeth and muscles [48]. Iron deficiency according to World Health Organization (WHO) affect about 3.7 billion people out of which 2 billion people are anemic [49].

Magnesium was the highest in germinated quinoa and potato puree (197.0 and 88.73 mg/100g) followed by amaranth flour was 22.5 mg/100g and the rice mill was the lowest in calcium. According to the [50] the magnesium, manganese, copper, and iron present in 100 g of quinoa mill cover the daily needs of infants and adults, while the phosphorus and zinc content in 100 g is sufficient for children, but covers 40–60% of the daily needs of adults. The potassium content can contribute between 18% and 22% of infant and adult requirements, while the calcium content can contribute 10% of the requirements.

Calcium, magnesium and iron are minerals that are deficient in gluten-free products and in the gluten free-diet. The inclusion of these pseudo-cereals, which are a good source of these and other important minerals, can assist to reduce this deficiency [51]. In general, the content of calcium in quinoa can contribute 10 % of the infant and adult requirements [52].

Vega-Galvez et al. [53] reported that the quinoa has higher total mineral (ash) content (3.4%) than rice (0.5%), wheat (1.8%), and other cereals [54]. The micronutrients calcium (275 to 1487 mg/kg), copper (2 to 51 mg/kg), iron (14 to 168 mg/kg), magnesium (260 to 5020 mg/kg), phosphorus (1400 to 5300 mg/kg), potassium (75 to 12000 mg/kg), and zinc (28 to 48 mg/kg) are present in sufficient quantities in quinoa to maintain a balanced human diet. Variations in mineral content are influenced by environmental conditions during plant growth and seed set, especially in soil mineral availability [19].

Good amounts of essential minerals were determined in amaranths like magnesium (848 µg/g), calcium (519.3 µg/g), phosphorus (330 µg/g) and iron (65 µg/g). Magnesium helps in maintaining blood pressure, diabetes, asthma, heart attack and bone health. Calcium helps in improving bone health and dental health, as well as the prevention of colon cancer and the reduction of obesity. Phosphorous reduces muscle weakness, boosts brain function and optimizes body metabolism, whereas Iron plays a vital role in the formation of hemoglobin, which guarantees circulation of the blood and oxygenation of various organ systems, maintains

body metabolism, muscle activity, anemia, brain function, immunity, insomnia and the regulation of body temperature [55].

Table 4: Minerals content of raw materials mg/100g:

Minerals content	Germinated quinoa flour	Potato puree	Amaranth flour	Rice mill
Potassium	826.7	955.0	326.8	320.0
Sodium	63.40	120.23	8.1	69.0
Calcium	108.12	88.73	190.7	133.0
Phosphorus	383.7	177.46	323.0	235.0
Copper	5.1	0.741	0.62	2.10
Iron	16.13	1.38	13.9	3.00
Manganese	197.74	88.73	22.0	1.80

Physical characteristics of different biscuits gluten and casein free:

The physical properties of different formulae biscuits prepared from germinated quinoa, amaranth flour, potato puree and rice mil and the results are shown in Table (5). The diameter of biscuits made from germinated quinoa and amaranth flour was found significantly lower than that of control biscuit ($p \leq 0.05$). The thickness of biscuits ranged from 0.51 to 0.52 cm. the slightly increased in thickness may be due to the decrease in diameter and the germinated quinoa and amaranth flour rich in dietary fibers. The changes in diameter and thickness were reflected in spread ratio and percent spread of biscuit. The spread ratio and percent spread of control biscuit was 8.52. Spread ratio and percent spread decreased with the addition of amaranth may be caused amaranth flour had the highest in crude fiber 10.80%. Reduced spread ratios of amaranth fortified biscuits were attributed to the fact that composite flours apparently form aggregates with increased numbers of hydrophilic sites available that compete for the limited free water in biscuit dough [56]. The weight of biscuits increased as the concentration of amaranth flour increased in the formulae. The range of biscuit weight was 4.68 to 4.93 g with maximum value in amaranth biscuits. The increase in biscuit weight was probably due to the ability of amaranth to retain oil during baking process [57]. Finely, the different formulae prepared from germinated quinoa, amaranth flour, potato puree and rice mil as it has beneficial nutraceutical properties and its gluten and casein free can play important role in preventing autism problem.

Table 5: Physical properties of biscuits gluten and casein free:

Formulae	Diameter (mm)	Thickness (mm)	Spread ratio (D/T)	Volume (Cm^3)	Weight (gm)	Specific volume (Cm^3/gm)
Control	4.6±1.20[a]	0.54±0.33[a]	8.52±0.67[a]	9.0[a]	4.56±0.22[a]	1.97[a]
Formula 1	4.1±1.45[c]	0.51±0.33[c]	8.04±0.25[c]	7.0[b]	4.93±0.23[c]	1.42[c]
Formula 2	4.2±1.45[b]	0.51±0.58[b]	8.24±0.67[b]	7.2[b]	4.87±0.34[b]	1.48[b]
Formula 3	4.2±1.00[b]	0.51±0.21[b]	8.24±0.05[b]	7.5[b]	4.72±0.08[b]	1.59[b]
Formula 4	4.3±1.23[a]	0.52±0.24[a]	8.27±0.38[a]	8.1[a]	4.80±0.22[a]	1.69[a]
Formula 5	4.3±1.22[a]	0.52±0.22[a]	8.27±0.37[a]	8.2[a]	4.68±0.18[a]	1.75[a]

Physical characteristics of different crackers gluten and casein free:

The physical properties (weight, high, volume and specific volume) of different formulae crackers prepared from germinated quinoa, amaranth flour, potato puree and rice mil and the results are reported in Table (6). From the table it could be observed that the when the weight in all formulae increased the volume was decreased. The changes in weight and volume were reflected to specific volume for crackers. The variation in these results may be caused the different crackers formulae had contained rich in fiber which absorption high amounts of water this could be increased the weight and decreased the volume.

Gluten-free and casein-free interventions limit food that contains gluten (e.g. breads, pastas, pizza, bagels, crackers, cakes, cookies, oats/ cereals, etc., made from wheat, barley, and rye) and casein (e.g., milk, cheese, cheese products, yogurt, ice creams, dips, sour cream, dressings, etc.). The existing studies on GFCF diet interventions are aimed at preventing gluten or casein from entering the blood-stream and thereby (theoretically) reducing/eliminating the symptoms of autism [58].

Table 6: Physical properties of cracker gluten and casein free:

Formulae	Weight (gm)	Height (mm)	Volume (Cm^3)	Specific volume (Cm^3/gm)
Control	1.73	27.0	2.6	1.50
Formula 1	1.85	27.0	2.5	1.35
Formula 2	1.77	27.0	2.7	1.53
Formula 3	1.75	27.0	2.8	1.60
Formula 4	1.70	27.0	2.9	1.71
Formula 5	1.82	27.0	2.6	1.82

Sensory evaluation of biscuits:

Appearance, odor, taste, color, crispy and total acceptability were evaluated in different formulae of biscuits free gluten and casein and the results are tabulated in Table (7). From the resultant it could be noticed that when increase amaranth flour the appearance, odor, taste, color, crispy and total acceptability were decreased. This may be caused the amaranth had contained rich in dietary fiber; meanwhile, quinoa had contained the highest amount in protein.

Sensory evaluation is considered to be a valuable tool in solving problems involving food acceptability. It is useful in product improvement, quality maintenance and more important in a new products development [59]. Biscuits represent a fast growing segment of food because of consumer demands for convenient and nutritious food products. The consumers demand has increased for the quality food products with taste, safety, convenience and nutrition [60].

Chevallier [61] suggested that protein content was negatively correlated with lightness of biscuits, indicating that the Maillard reaction played the major role in color formation. Maillard browning and caramelization of sugar is considered to produce brown pigments during baking. The biscuit color is an important factor for the initial acceptability of food products by consumers.

Table 7: Sensory evaluation of biscuits gluten and casein free:

Formulae	Appearance (20)	Odor (20)	Taste (20)	Color (20)	Crispy (20)	Total score (100)
Control	20.0±0.12^{a}	20.0±0.25^{a}	20.0±0.11^{a}	20.0±0.13^{a}	20.0±0.10^{a}	100.0
Formula 1	17.0±1.04^{d}	19.0±0.92^{c}	17.0±1.13^{d}	17.0±1.07^{c}	18.0±1.29^{c}	88.0
Formula 2	18.0±1.16^{c}	19.5±0.93^{b}	18.0±1.00^{c}	18.0±1.00^{b}	18.5±1.26^{bc}	92.0
Formula 3	19.0±0.83^{b}	20.0±0.02^{a}	19.0±0.71^{b}	18.0±0.95^{b}	19. 0±0.91^{b}	95.0
Formula 4	19.0±0.63^{b}	20.0±0.01^{a}	19.0±0.54^{b}	20.0±0.04^{a}	19. 0±0.46^{b}	97.0
Formula 5	20.0±0.01^{a}	20.0±0.01^{a}	19.0±0.68^{b}	20.0±0.01^{a}	19. 0±0.72^{b}	98.0

Sensory evaluation of crackers:

Appearance, odor, taste, color, crispy and total acceptability were evaluated in different formulae of crackers free gluten and casein and the results are reported in Table (8). From the resultant it could be noticed that the results from the Table (8) was paralleled and ensure the results from Table (7) which showed the results of different formulae of biscuits free gluten and casein.

Some children with autism will only eat certain foods due to sensory issues. A food's texture, color, smell, shape, and familiarity can determine whether a child will prefer a food. How the food feels in the child's mouth is one sensory issue that determines whether they will eat the food or not [62]. The color and shape of the food may cause a child to be hypersensitive or hyposensitive during a meal. A child "may be hypersensitive to the texture, smell, and temperature of foods and become easily overwhelmed during mealtime, triggering a tantrum and food refusal" [63].

Table 8: Sensory evaluation of cracker gluten and casein free:

Formulae	Appearance (20)	Odor (20)	Taste (20)	Color (20)	Crispy (20)	Total score (100)
Control	20.0±0.01^{a}	20.0±0.01^{a}	20.0±0.02^{a}	20.0±0.01^{a}	20.0±0.01^{a}	100.0
Formula 1	18.0±0.83^{bc}	19.0±0.72^{b}	16.0±1.05^{d}	18.0±0.76^{c}	19.0±0.59^{b}	90.0
Formula 2	18.0±0.37^{c}	20.0±0.02^{a}	18.0±0.92^{c}	19.0±1.01^{b}	19.5±0.98^{ab}	94.5
Formula 3	19. 0±0.73^{b}	20.0±0.01^{a}	19.0±0.86^{b}	18.0±1.04^{c}	20.0±0.04^{a}	96.0
Formula 4	19.0±0.86^{b}	20.0±0.01^{a}	19.0±0.84^{b}	20.0±0.02^{a}	19.5±0.76^{ab}	97.5
Formula 5	20.0±0.01^{a}	20.0±0.02^{a}	19.0±0.48^{b}	20.0±0.02^{a}	19.5±0.07^{ab}	98.5

The present study has contributed to understanding the potential of amaranth flour and germinated quinoa is an excellent source of phytochemical, minerals content, dietary fiber and protein. The various experimental analyses carried out on amaranth flour and germinated quinoa revealed its potential as a good nutraceuticals, thereby, offering various health benefits.

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