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# A Review on Effects of Pseudo Cereals Flour on Quality Properties of Biscuit, Cookies and Cake

*Abu Saeid and Maruf Ahmed*

## Abstract

Gluten free products are currently highly demandable by those with different gluten intolerances. Pseudo cereals are a category of non-grass seeds used to manufacture various gluten free products, including bread, biscuits, cakes, and cookies. Pseudo cereal seeds contain high-quality proteins, rich quantities and unique characteristics of starch, vast amounts of micronutrients such as minerals, vitamins along with diverse bioactive compounds. This chapter is focused on other resentful research work on the characteristics of pseudo cereals seeds and pseudo cereals flour. It also reveals different effects of pseudo cereal flour on physical-chemicals properties of biscuit, cake, and cookie. We think that this study will have a significant influence on product developers and customers on the use of pseudo cereal seeds and pseudo cereals flour.

**Keywords:** pseudo cereals seeds, pseudo cereals flour, biscuits, cake, cookies

## 1. Introduction

Pseudo cereal is a category of non-greases that can be ground into flour and then used as cereals. Most of the pseudo cereals are amaranth (*Amaranthu* spp.), quinoa (*Chenopodium quinoa*), and buckwheat (*Fagopyrum esculentum* and *Fagopyrum tartaricum*). Pseudo cereals have high-quality proteins, rich in starch, minerals, vitamins, and bioactive compounds. Pseudo cereals could be the alternative option for developing gluten free food products for people suffering from various gluten intolerances. That is why interest in pseudo cereals has increased enormously since the turn of the century, and research has intensified [1].

Buckwheat (*Fagopyrume sculentum*) is nutritionally enriched due to its high amount of vitamin B<sub>1</sub> and B<sub>2</sub>, proteins with significant amount of essential amino-acid. It is a rich source of flavonoids, phytosterols, soluble carbohydrates, and other substances like D-chiro-inositol, fagopyritols, or thiamine-binding proteins [2]. Buckwheat also contains a higher amount of rutin (quercetin-3-rutinoside) than other crops with significant antioxidant, anti-inflammatory, and anticarcinogenic properties. Food products made from buckwheat which have many different biological effects, include promoting intestinal microbiota and growth support of colonies of lactic acid bacteria in the gastrointestinal tract, inhibiting proteases' scavenging ability of free radical, glucose- and cholesterol-lowering effects [3].

Amaranth (*Amaranthus* L.) has a higher amount of protein content (14–19%) than that of other traditional cereal crops with almost an acceptable proportion of essential amino acids which are rich in lysine and methionine [4]. The quality of starch content is low and there is no amylose (approximately 10% of starch, while amylopectin is 90%). Amaranth contains a good source of flavonoids and tocotrienols. Besides, lipid content is essential in amaranth seed included 6-7% of squalene compounds can reduce cancer risk, lipid metabolism control, anti-aging effects on the skin, and positive implications on the human immune system. Amaranth is also a rich source of magnesium, potassium, phosphorous and zinc minerals [5].

Quinoa (*Chenopodium quinoa* Willd) is rich in macronutrients, especially proteins which are analogous to the quality of the casein. Quinoa contains protein that is gluten free because of the lack of prolamins. Quinoas possess useful levels of lipids, such as monounsaturated fat (as oleic acid) and small quantities of omega-3 fatty acids such as alpha-linolenic acid, which are safe for health. It also contains higher fiber, mineral and carbohydrates such as polysaccharides that have a low glycemic index. Quinoa also is a pioneer in phytochemicals, antioxidants such as tocopherols and flavonoids such as quercetin and kaempferol [5–7]. Quinoa contains saponins and other valuable micro- and macronutrients [8].

Pseudo cereals have been widely recognized for many years due to their nutritional value by food scientists and food producers [1]. Many studies have investigated the use of pseudo cereals in the production of gluten free products rich in nutrients such as bread, pasta and confectionary products [8]. Flour, soup, cereal breakfast as well as beer are made using quinoa. Quinoa flour is used with wheat flour or corn meal to make biscuits, bread and processed food such as spaghetti [9]. On the other hand, buckwheat is used as a food supplement that can have a positive health impact and avoid foods being oxidized during processing. Buckwheat is recognized and recorded as part of wheat bread [10, 11]. Amaranth grain has high-quality protein, and flour is used in non-gluten formulations to obtain decent quality bread and cookies [12]. Hozova et al. [13] also proposed the use of amaranth flour to manufacture high-protein/energy-value gluten-free crackers and biscuits.

## **2. Types and characteristics of pseudo cereals**

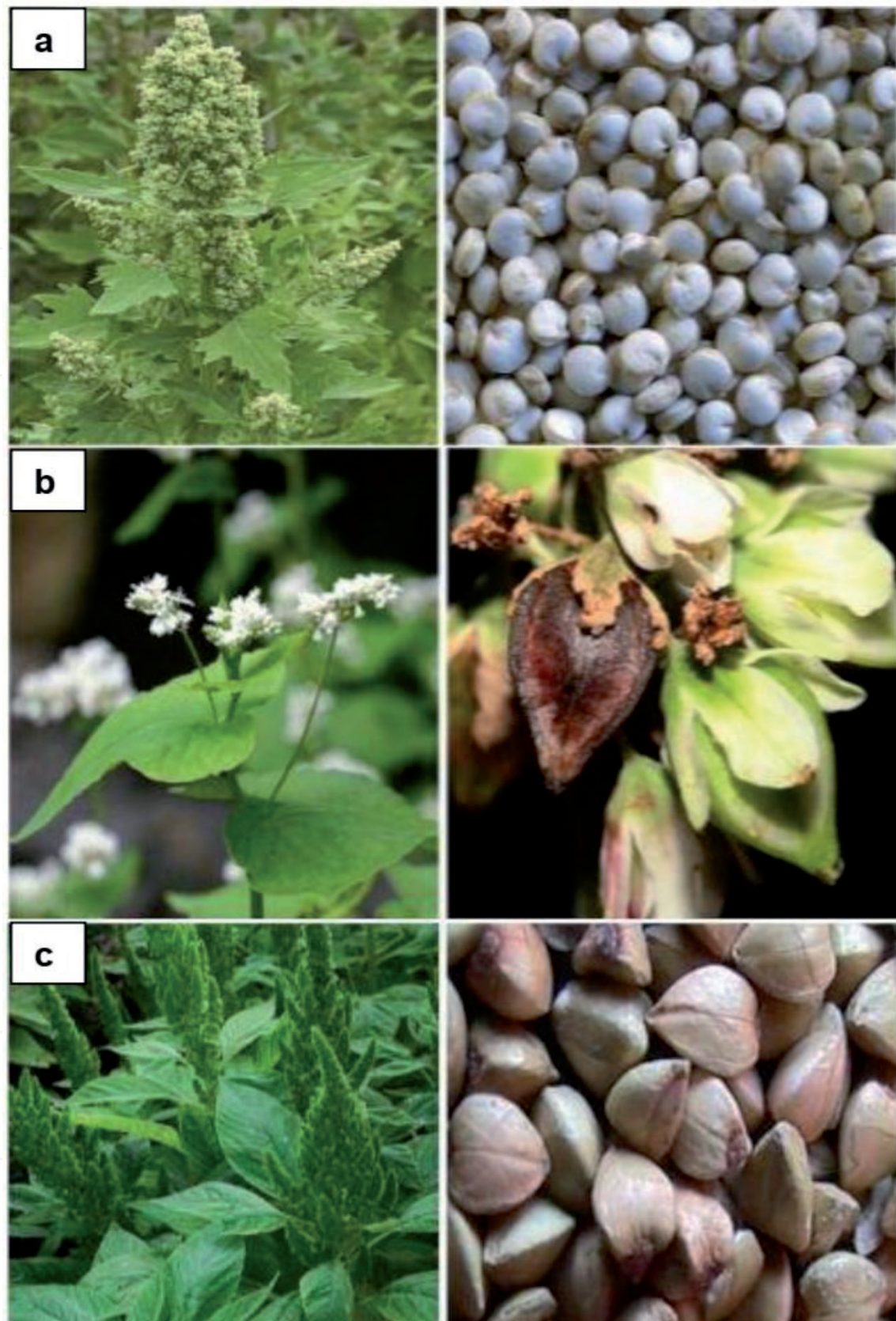
Pseudo cereals are non-grass species, eaten as grains, and having nutritional value is competitive or in most cases even better [14]. Amaranth (*Amaranthus* L.), quinoa (*Chenopodium quinoa*) and buckwheat (*Fagopyrum spp.*) are the main cereal-referential species (**Figure 1** and **Table 1**). Pseudo grain is not actual grain; it is dicotyledonous and pseudo grain is equivalent to true grain composition (**Table 2**). Hull (whether glossy or dull, brown, black or gray), testa, aleurone and starchy endosperm that occupy most of the seed (**Figure 2**) are the principal components of the buckwheat kernels (where there is perisperm absent). Pseudo cereal grain constitutes a healthy protein source, amino acids, vitamins, minerals and fatty acids [24]. In amaranth and quinoa seeds higher protein and fat levels are observed compared to common cereals due to high concentrations of amaranth and quinoa bran [25].

## **3. Nutritional compositions and application of pseudo cereals**

### **3.1 Buckwheat**

Buckwheat (BW), which belongs to the Polygonaceans families, is a typical Central and Eastern Europe and Asia crop. BW is widely used as a pseudo cereal





**Figure 1.**  
*Different types of leaves and seeds pseudo cereals: (a) quinoa; (b) buckwheat; (c) amaranth.*

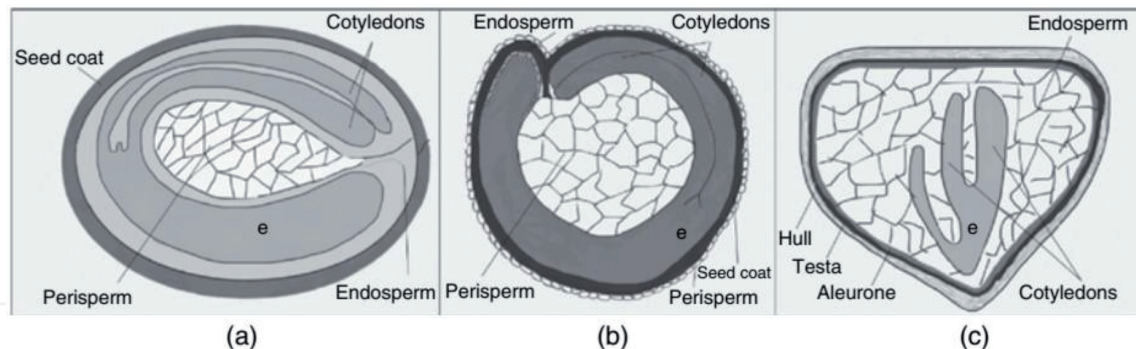
as an essential functional food. Grains of BW provides various valuable vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, and E) and minerals (P, Fe, Zn, K, and Mg) [26]. The biological value of BW proteins is high, but their digestibility is relatively low. The BW protein amino acids are well-balanced and rich in lysine [27] (**Table 2**). Besides, the contents of rutin, catechins, and polyphenols and their potential antioxidant activity are also of

	Cereals							Pseudo cereals			
Name	Wheat	Rye	Barley	Oat	Rice	Corn	Sorghum	Millet	Amaranth	Quinoa	Buckwheat
Class	Monocotyledoneae							Dicotyledoneae			
Order	Poales							Caryophyllales			
Family	Poaceae							Amaranthaceae		Polygonaceae	
Subfamily	Pooideae		Bambusoideae				Panicoideae	Amaranthoideae	Chenopodioideae	Polygonoideae	
Tribe	Triticeae		Poeae	Oryzaceae			Paniceae		Amaranthaceae	Chenopodieae	Fagopyreae
Genus	<i>Triticum</i>	<i>Secale</i>	<i>Hordeum</i>	<i>Avena</i>	<i>Oryza</i>	<i>Zea</i>	<i>Sorghum</i>	<i>Pennisetum</i> <i>Panicum</i> <i>Setaria</i> <i>Paspalum</i>	<i>Amaranthus</i>	<i>Chenopodium</i>	<i>Fagopyrum</i>
Species	<i>T. aestivum</i> , <i>T. aestivum</i> spp., <i>T. spelta</i> , <i>T. durum</i>	<i>S. cereals</i>	<i>H. vulgare</i>	<i>A. sativa</i>	<i>O. sativa</i>	<i>Z. mays</i>	<i>S. bicolor</i>	<i>P. glaucum</i> (pearl millet) <i>P. meliaceum</i> (proso millet) <i>S. italica</i> (foxtail millet) <i>P. sacrobiculatum</i> (kodo millet)	<i>A. caudatus</i> , <i>A. cruentus</i> , <i>A. hypochondriacus</i>	<i>Ch. quinoa</i> Wild, <i>Ch. pallidicaule</i> Allen (kanigua/ canihua) <i>Ch. nuttalia</i> Safford	<i>F. tartarum</i> <i>F. esculentum</i> Moench

**Table 1.**  
Botanical classification of cereals and pseudo cereals [15, 16].

Parameters	Wheat flour	Quinoa flour	Buckwheat flour	Amaranth flour
Moisture (%)	10.12	9.97	9.72	6.21
Ash (%)	0.48	2.28	1.92	2.53
Protein (%)	11.2	12.4	11.5	17.0
Cellulose (%)	0.60	2.6	1.3	5.54
Fat (%)	0.70	5.3	2.4	4.90
Phytic acid/Phytate (mg/100 g)	196.0	1574	1335	237.75
Phytate phosphorus (mg/100 g)	38.35	443.88	376.48	—
Minerals (mg/100 g)				
Ca	20.05	30.5	179.6	1533.0
Cu	0.31	0.81	0.78	0.52
Fe	1.38	4.10	2.87	1.40
K	181.4	681.1	479.8	200.0
Mg	29.9	174.3	190.6	68.5
Mn	0.37	1.6	1.23	1.02
P	208.7	504.3	444.8	257.74
Zn	1.23	4.04	3.01	0.21

**Table 2.**  
 Chemical composition of wheat and pseudo cereals flours [17–21].



**Figure 2.**  
 Longitudinal sections of seed structures of the three major groups of pseudo cereals: (a) amaranth; (b) quinoa; (c) buckwheat [22, 23].

great significance [28]. BW does not contain gluten and can be used in celiac disease patients. Resistant starch content is a significant factor in BW 's preparation of low glycemic index food [28]. Some early studies also showed that BW flours and bran could prepare different bakery products, pasta-noodle, cookie, cake, crepe, breakfast cereal and soap formulations [11, 29, 30].

### 3.2 Amaranth

Amaranth (*Amaranthus* spp) is an indigenous pseudo grain domesticated in South America and has potential worldwide agronomic value [22]. Amaranth is a highly nutritious pseudo cereal that does not contain gluten. Due to its high protein content and its similar composition of essential amino acid [31], amaranth seed nutrient quality is superior to that of most cereal grains (Table 2). Additionally,



lysine is abundant in amaranth grain, which is typically deficient in cereal grains. The overall content of minerals, especially calcium and magnesium, is generally more significant than observed in the grains [8]. Amaranth grain can be toasted, popped, extruded or milled into flour, thus eaten as various cereal products, including bread, cakes, muffins, cookies, dumplings, crepes, noodles and crackers. Some studies have found that amaranth grain could be used in gluten free goods such as crackers, maize tortillas, chips and bread [32, 33]. It is also used in foodstuffs to increase nutritional supplies that typically lack a celiac diet [34].

### 3.3 Quinoa

Quinoa belongs to the *chenopodiaceae* family, genus *chenopodium* is a pseudo cereal of the Andean regions of South America [35]. Quinoa seed can constitute a rich source for essential fatty acids, including linolenic (18:2n-6:52%) and linolenic (18:3n-6:40%) [36]. Quinoa is a good protein source, provided the nutritional profile of the material (12-18 g/100 g in dry weight), fiber, vitamins (such as C, E and B complex), calcium, magnesium, iron, copper and zinc have powerful content [35]. Several antinutrients, including saponins, phytic acid, tannins, protease inhibitors and others, have been found in quinoa [37]. The amino acid balance of quinoa is higher than the lysine based wheat and maize [38]. Quinoa flour can be added as a substitute for wheat flour as in bread (10–13% quinoa flour), noodles and pasta (30–40% quinoa flour), and sweet biscuits (60% quinoa flour) [39].

## 4. Impact of pseudo cereals flours on quality parameters of biscuits, cookies and snacks

### 4.1 Buckwheat biscuits and snacks

Increased market demand for composite flour based bakery products such as biscuits, snacks, or cereals has recently been noted. Buckwheat flour biscuits and corn snacks were produced by Wójtowicz et al. [40] and Baljeet et al. [41], using buck wheat up to 20% and 30%, respectively. Buckwheat flour biscuits are nutritionally rich (**Table 3**) [41]. Filipčev et al. [43] have successfully integrated buckwheat flour (up to 50%) and made biscuits of ginger nuts and have found higher nutritional and bio-functional properties compared to control (**Table 4**). Biscuit thickness increased while the spread ratio and percent spread decreased due to decreased diameter with the inclusion of buckwheat flour (**Tables 3 and 4**) [41]. On the other hand, with the integration of buckwheat flour, biscuits' texture decreased in terms of (fracture strength) due to the decreasing gluten content in the buckwheat flours, the biscuits became soft with increasing BWF content [41]. The increase in the weight of biscuits was possibly due to buckwheat flour's ability to hold oil during baking [44]. Baljeet et al. [41] found that an improvement in the percentage of buckwheat flour in composite flour decreases the biscuit's sensory ranking.

### 4.2 Amaranth snacks and cookies

The protein and ash content of defatted amaranth snacks was higher, while the carbohydrate and lipid content were lower than maize snacks [45]. Compared to cookies made from wheat flour, the spread of cookies made with amaranth flour decreased significantly at 10-20%. Cookie thickness increased by up to 20% with the addition of amaranth flour, with marginal changes in thickness were observed.

Parameters	Control	Buckwheat		
		30%	40%	50%
Moisture content, g/100 g	9.47	8.94	8.56	8.70
Protein content, g/100 g	7.22	7.73	7.84	8.12
Fat content, g/100 g	8.12	8.43	8.45	8.59
Starch content, g/100 g	45.80	43.64	43.77	43.21
Total reducing sugar content	29.37	25.33	25.90	27.29
Total dietary fibers content, g/100 g	3.87	5.49	5.37	7.61
Zn mg/100 g	0.34	0.78	1.00	1.16
Cu, mg/100 g	0.07	0.15	0.16	0.22
Mn, mg/100 g	0.61	0.88	0.88	0.93
Fe, mg/100 g	0.57	1.39	1.66	1.72
Rutin content, mg/100 g	ND*	3.96	5.24	6.57
Quercetin content, mg/100 g	ND*	0.087	0.143	0.214
Total phenolics, mg GAE/100 g	157.06	196.35	202.58	238.92

ND\*-Not detected.

**Table 3.**  
 Chemical composition of buckwheat supplemented ginger nut biscuits (dry basis) [42].

Parameters	Control	Buckwheat		
		30%	40%	50%
Antioxidative activity (AOA)	32.51	26.71	25.37	23.83
Reducing activity	29.36	28.46	28.00	26.2
DPPH scavenging activity	23.06	10.79	9.66	5.25
Chelating activity	11.24	11.84	11.35	11.21

**Table 4.**  
 Antioxidant potential profile ( $IC_{50}$ , mg/ml) of buckwheat supplemented ginger nut biscuits [42].

The breakage of the cookies decreased significantly with the addition of amaranth flour (Tables 5 and 6). Similar conclusions were observed in cookies from sorghum-wheat and oat-wheat mixtures. Hosoney and Rogers [47] reported that cookies' hardness is caused by protein and starch interactions with hydrogen bonding systems. It was noted that the diameter of composite cookies shows a rising trend along with the increasing degree of substitution of amaranth flour. This may be attributed to the lower viscosity of amaranth flour than wheat flour, as the viscosity decreases with the increase of the volume of amaranth flour and the spread rate. The results reveal that the spread ratio of the composite cookies displayed an increasing trend along with the increasing substitution level of amaranth flour. The decreased durability of amaranth flour replacement in cookies could be due to changes in gluten content. The delayed production of gluten matrices, which has contributed to an enormous decline in hardness, is also attributable to gluten reduction in cookie dough by the substitution of Amaranth flour [46]. Chauhan et al. [48] no major change was observed in color, aroma and texture of cookies made from mixtures with up to 100% amaranth flour. The sensory score for the taste decreased after addition of amaranth flour of 60%. This may be attributed to the bitter aftertaste of the amaranth flour. The overall acceptability score indicated that the cookies prepared up to 60% amaranth flour



Amaranth flour (%)	Weight (g)	Spread “W” (mm)	Thickness “T” (mm)	Spread ratio “W/T”	Breaking strength (kg)
0	19.46c ± 0.11	85.6a ± 0.66	10.9d ± 0.08	7.82a ± 0.03	4.935a ± 0.19
10	18.90d ± 0.21	81.30b ± 0.55	12.2a ± 0.08	6.69b ± 0.03	4.990a ± 0.28
20	19.72b ± 0.23	79.0bc ± 0.81	12.1ab ± 0.09	6.52c ± 0.14	4.887a ± 0.21
25	19.90a ± 0.13	77.6 cd ± 0.72	11.9b ± 0.11	6.52c ± 0.09	4.021bc ± 0.22
30	19.70b ± 0.18	75.9 dc ± 0.81	11.6bc ± 0.09	6.52c ± 0.10	3.948c ± 0.25
35	19.72b ± 0.15	75.0 dc ± 0.95	11.5c ± 0.13	6.52c ± 0.04	3.0293d ± 0.32
SEM (±)	0.10	0.15	0.13	0.08	0.12
Df	18	18	18	18	54

Note: Values for a particular column differ significantly when followed by different letters ( $p < 0.05$ ); SEM, standard error of meant at 30 degrees of freedom.

**Table 5.**  
Effect of replacement of wheat flour with amaranth flour on the sensory characteristic of cookies [46].

Amaranth flour (%)	Surface color (10)	Surface cracking (10)	Texture (10)	Mouthfeel (10)	Flavor (10)	Overall quality (50)
0	8.0c	7.8d	8.5b	8.5b	8.4c	40.7d
10	8.0c	8.0c	8.2c	8.5b	8.5b	41.2c
20	8.5b	8.2b	8.1 cd	8.4bc	8.5b	41.7c
25	8.8a	8.5a	8.6a	8.6a	8.7a	43.2a
30	8.9a	8.4a	8.5a	8.5b	8.6ab	42.9ab
35	8.7a	8.5a	8.5a	8.6ab	8.6b	42.4b
SEM (±)	0.10	0.12	0.11	0.14	0.14	0.23

Note: Values for a particular column differ significantly when followed by different letters ( $p < 0.05$ ); SEM, standard error of meant at 30 degrees of freedom.

**Table 6.**  
Effect of replacement of wheat flour with amaranth flour on the physical characteristic of cookies [46].

had most acceptable sensory attributes. This was against Sindhuja et al. [46], which showed that cookies with 25% amaranth flour were most acceptable for panelists. It has been reported that, no significant difference was demonstrated in color, smell, texture of biscuits made from 20, 30, 40 and 50% of amaranth flour but biscuit made from 40 and 50% of amaranth flour had significantly higher value than wheat flour (control). Overall acceptability score showed that biscuit made from maximum 40% amaranth flour best good sensory attributes [49].

### 4.3 Quinoa cookies and biscuits

The Demir and Kılınc study [50] that cookie samples have significantly increased ash, crude protein and crude fats ( $p < 0.05$ ) with the addition of quinoa meal. In cookies made with different amounts of quinoa flour, the meaningful effect ( $p < 0.05$ ) for the total content of K, Mg, Ca, Fe and Zn has been observed. Calcium, magnesium, iron and zinc are usually greater in quinoa than ordinary cereals, and their iron contents are very high [51, 52]. The use of quinoa flour was stated to lead to a slight increase in product thickness, but the cookie samples’ spread ratio and diameter decreased [50]. When quinoa flour added, the hardness of cookies increased by up to 30% [53]. The sensory characteristics of cookie

samples were influenced by quinoa flour. Added quinoa flour had statistically significant color, taste, crispness and total acceptability except odor ratings. Biscuits made of 100% quinoa flour ( $p < 0.05$ ) vary considerably from the controls.

## 5. Conclusion

Pseudo cereal is a house of high-quality proteins with essential amino acids. It can be used to formulate gluten free food items as an alternative to wheat proteins in subjects suffering from celiac disease, due to the absence of gluten. In addition to the excellent nutrient profile, pseudo cereals are promising sources of phytochemical substances with significant health-promoting properties. Today pseudo cereals like buckwheat, quinoa and amaranth are incorporated successfully in bakery items such as biscuits, cookies, breads and snacks. Up to 50% buckwheat flours were used to produce nutritionally rich ginger-based biscuits with wheat flour. There was no loss of customer acceptance for the 60% amaranth flour used in the cookies production. Besides, the hardness of cookies increased by up to 30% of quinoa meal. This chapter also highlighted the actual color, taste, texture, and nutritional properties of pseudo cereal flour on biscuits, cookies, and the cake quality. Therefore, we assume that this study would considerably affect developers and customers and extensive understanding of pseudo cereal seeds and pseudo cereal flour.

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