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Preparation and Evaluation of High Nutritional Value Dried Lentil Soup

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ABSTRACT

This study developed three novel dried soup mixes lentil vegetable (L1), lentil-vegetable-noodle (L2), and lentil-vegetable-broken rice (L3) and evaluated their nutritional, technological, and sensory properties against a commercial control (C) over six months. The evaluation included proximate composition, bioactive compounds, antioxidant activity, mineral content, color, viscosity, rehydration capacity, water activity, and sensory attributes. Results showed that L1 possessed the highest protein (23.52%), antioxidant activity (6.86% inhibition), and carotenoid content (6.68mg/100g), along with optimal viscosity and the lowest fat (1.00%). L2 had the highest mineral content (Fe: 4.33, Zn: 5.34 mg/100g). Sensory, L1 and L2 maintained the highest overall acceptability, significantly outperforming the control throughout storage. In conclusion, supplementing lentil soup with vegetables (L1) or noodles (L2) enhances its nutritional profile, functionality, and shelf life. L1 is highly recommended for its superior overall quality, offering a nutrient-dense and convenient food product for consumers.

1. Introduction

People are living stressful lifestyles as a result of urbanization, leading to a reliance on unhealthy, nutrient-deficient junk foods. Unhealthy nutrient-deficient junk foods. This issue can be addressed by developing high-nutrient foods that require minimal preparation time. Dried soup powder is one such easy-to-cook option that can meet consumer demand for convenience (Farzana et al., 2017). To be successful, however, these convenient products must also be appealing and nutritionally valuable, which leads to a focus on value-added formulations.
The development of value- added products is therefore a key target, as they can provide both nutritional benefits and a delicious taste to consumers (Monteiro, et al., 2014). Soup is an ideal vehicle for such fortification, as it is a widely accepted food that stimulates appetite and provides quick nourishment (Cecil et al., 1999). Dehydrated foods, particularly, dry soup mixes, offer several advantages including protection against enzymatic and oxidative deterioration and enhanced flavor stability during prolonged storage at room temperature (6 - 12 months). Moreover, they do not require refrigeration and retain a considerable nutritional value, particularly as a rich source of protein. These products are also convenient for rapid reconstitution, making them suitable for working families, hotels, hospitals, restaurants and institutional use and military rations. In addition, their lightweight nature facilitates transportation and ensures year-round availability (Rekha. et al., 2010). Lentil represents an affordable and accessible source of dietary protein in many parts of the world, especially in South Asia where plant-based diets predominate. It is also widely consumed across Sub-Saharan Africa, West Asia, North America, Middle East, Europe and Australia (Rekha et al., 2010). Lentil is a highly nutritious legume characterized by a substantial content of carbohydrates, proteins, minerals, vitamins, phytochemicals and dietary fibers (Joshi et al., 2017). It serves as an excellent source of both soluble and insoluble dietary fibers and essential micronutrients and

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it contains valuable bioactive compounds such as phytosterols and tocopherols (Ryan et al., 2007). Amal and Azza, (2014) demonstrated supplementing dried vegetarian soup mixtures with legumes significantly enhanced nutritional and technological attributes, with lentil being the most valuable addition exhibiting the highest sensory acceptability. Broken rice (*Oryza sativa* L) is a by-product generated during the grain polishing from process in rice mills and consists of fragments that are not intact, represents the initial stage of rice processing, producing brown rice, which is subsequently subjected to polishing or whitening. However, certain quality losses occur during milling, which remains a major challenge for the rice industry (Payman et al., 2006). It has been estimated that approximately 9.7 million metric tons, representing about 36.6% of the total broken rice produced globally in 2020, were utilized for animal feed and other non-human food applications (Childs, 2020). On the other hand, beyond the carrots roots in salads and curries in India, they can be commercially processed into nutritionally rich products such as juices, concentrates, dried powders, canned goods, preserves, candies and pickles (Krishan et al., 2012). The present study was designed to develop and evaluate different types of dried lentil soup mixes incorporating lentils, vegetables, rice, and noodles. Three formulations of dried soup mixes were prepared and compared with a commercially available standard lentil soup sample. The chemical composition, rheological behavior, and sensory characteristics were analyzed to assess the nutritional and technological quality of the developed soup mixes and their corresponding reconstituted soups.

2. Materials and Methods

Materials

Lentil seeds and broken rice were obtained from the Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Fresh carrots, tomatoes, onion, garlic, black pepper, wheat flour, Cumin, salt control sample, were purchased from a local market in Cairo, Egypt. All chemical reagents were of analytical grade and sourced from Al-Gomhoria Chemicals Company. The prepared soup mixtures were packed in polypropylene bags and stored at room temperature (20±5°C) in a dry place) for six months.

Methods

Preparation of noodles

The noodle formula consisted of 100g of wheat flour, 40 ml of water and 0.5g of salt, the prepared dough was placed to rest in a plastic bag for 30 minutes. The dough was passed through a small noodle hand machine for several times with the rollers gap gradually reduced, the noodle strands were cut with a sharp knife to the appropriate length (12 cm). After cutting, the noodles were steamed at 100°C for 3 minutes and then tempered in an oven at 50°C for half an hour. The instant noodles were packed in polyethylene bags until ready to use according to Nermin (2013).

Preparation of lentil soup

Lentil seeds were cleaned, washed and cut after which fresh ingredients were mixed and spices were added. The mixture was then cooked on heater at 100°C for 20 min. with continuous stirring. The cooked soup was thoroughly blended using a planetary mixer (Moulinex, France) for 3 min. to ensure uniform consistency. The soup mixtures were subsequently dried in electric oven at 70°C for 2 hr followed by further drying at 45°C overnight until complete dehydration. The dried soup mixtures were then milled into a fine powder to enhance their nutritional value and functional properties and sieved through a 0.28mm. Finally, the powdered soup mixes were packaged in multilayer packaged bags to protect against moisture and gas transmission and stored at room temperature until further use.

Proximate analysis of raw materials and energy of the dried soup mixtures

Moisture, ash, total fat, fiber and crude protein contents were determined according the methods described by (AOAC, 2019) Moreover, available carbohydrates was calculated by difference. The Energy value (kcal/100g) of the different dried soup mixtures was calculated using the equation reported by (James 1995).

Energy value (kcal/100g) = [(% carbohydrate × 4) + (% protein × 4) + (% fat × 9)].

All results were recorded as the mean value of 3 replicates.

Table 1. Ingredients of different soup mixtures (g/100g)

Ingredients (%)	L1	L2	L3
Lentil	62.5	42.5	42.5
Instant noodles	----	20	------
Brecken rice	------	------	20
Fresh carrots	15	15	15
Fresh tomatos	12	12	12
Fresh onion	5	5	5
Fresh garlic	2.5	2.5	2.5
Salt	2	2	2
Black pepper	0.4	0.4	0.4
Cumin	0.6	0.6	0.6
Total	100	100	100

Organoleptic evaluation of the different dried soup mixtures

The different dried soup mixtures were organoleptically evaluated after reconstitution in a hot water (10g dried soup mixtures/65ml water) to assess their sensory characteristics, including taste, color, aroma, flavor and overall acceptability. The evaluation was conducted by panel of ten trained panelists according to the method described by (Wang et al., 2009) with minor modifications.

Color measurement of different dried soup mixtures

The color of the dried soup mixtures was measured according to the method described by McGurie (1992) using a hand-held Chromameter (Model CR-400, Konica Minolta, Japan).

Rehydration ratio (RR) of different dried soup mixtures

The Rehydration ratio was determined according to the method described by (Krokida and Marinos-Kouris (2003). (2g) portion of the dried soup mixture was rehydrated in 20ml distilled water in a water bath maintained at a constant temperature and agitated at a constant speed of (100 rpm). After 10 minutes, the samples were removed from the bath, gently blotted with tissue paper to remove excess surface water, and weighed. The Rehydration ratio was expressed defined as the ratio of weight of rehydrated samples its initial dry weight.

Determination of minerals

Minerals content as calcium, zinc, and iron in the different dried soup mixtures were determined using an Atomic Absorption Spectrophotometer (Perkin Elmer model 3300, Merck hydride system USA) according to the methods of AOAC (2019).

Determination of total phenolic compounds (TPC) in different dried soup mixtures

The total phenolic content was determined colorimetrically according to the Folin-Ciocalteu method described by (Zilic et al., 2012).

Determination of antioxidant activity of different dried soup mixtures: free radical DPPH scavenging activity

The Free radical scavenging capacity of extracts was determined using the stable DPPH method according to Hwang and Do Thi, (2014). The absorbance was measured at 517nm using a spectrophotometer (Model 6405 UV/VIS, Jenway, England) against a blank of pure methanol after 60 minutes of incubation in the dark. The percentage inhibition of the DPPH free radical was calculated using the following equation:

Inhibition(%) =100×[(A control-A sample)/A control]

Where: A control is the absorbance of the control reaction (containing all reagents except the test compound) and A sample is the absorbance in the presence of the test compound. The concentration of sample providing 50% inhibition (IC50) was calculated using linear regression analysis.

Determination of total flavonoids

The Total flavonoids content of the tested samples was determined according to the method by

Jia et al. (1999). The results were expressed as milligrams of quercetin equivalents per 100 g sample of dry sample.

Determination of carotenoids

The carotenoids of the samples was determined according to the methods described by Holm (1954) and Wetsttein (1957). Five grams of each sample were mixed with 30 ml of 85% acetone in dark bottles and kept at room temperature for 15 hrs. The mixture was then, filtered through glass wool into a 100 ml volumetric flask, and made up to volume with 85% acetone solution. The absorptions of the prepared extracts was measured using spectrophotometer at wavelengths of 662, 644 and 440 nm. A blank sample containing acetone (85%) was used as a reference. The total carotenoid content was then calculated accordingly.

Total carotenoids (mg/L) = 4.695 ×E440 – 0.268× (Chlorophyll A+B).

Rheological properties of the resultant soup samples

The rheological properties (viscosity) of the dried vegetarian soup samples were measured according to Brookfield Manual (1998) by using Brookfield Engineering labs DV-III Ultra Rheometer. Each sample was placed in a small sample adapter and a constant temperature water bath was used to maintain the desired temperature during measurement. The viscometer was operated at speeds ranging from 10 and 60 rpm. And viscosity data were recorded directly from the instrument. The SC4-21 spindle was used for all measurements Rheological measurements were performed for the resultant soup samples (C, L1, L2 and L3) at room temperature (25˚C ± 1˚C).

Water Activity (a_w) of Different Dried Soup Mixtures during the Storage Period:

The water activity (a_w) of the different dried soups mixtures was measured during storage period using Rotronic Hygrolab 3CH-8303, (Switzerland) according to the method described by (Cadden, 1988).

Statistical analysis

The data from this study were statistically analyzed using the Costat statistical software for means and standard deviations (Steel et al., 1997). The data were subjected to one-way analysis of variance (ANOVA) using one way, followed by Duncan's multiple range tests (at $p<0.05$) to assess differences between sample means.

3. Results and Discussion

Chemical composition of raw materials

The chemical composition of raw materials yellow lintel, broken rice and noodles are shown in Table 2 on a dry weight basis. The proximate analysis reveals significant differences in their nutritional profiles. Yellow lentils had a higher amount of protein (25.40%), which was higher than rice and noodles, also, it contained 1.36, 2.61, 3.31, and 57.84 for fat, ash, fiber, and carbohydrate, respectively, which was similar to that reported in yellow lentil by (Daniel et al., 2021) who indicated that yellow lentil flour contains 25.16% protein, 1.2% fat and 62.69 % carbohydrate. In contrast, broken rice showed the lowest protein (7.21%) but the highest carbohydrate content (81.22%), highlighting its role primarily as an energy-dense food source rather than a protein contributor. Ayman et al., (2019) found that the Egyptian rice had 6.33% protein, 0.77% fat, 0.53% ash, and 0.83% crude fiber, which are near to our results. Noodles, however, presented an intermediate protein level (12.08%) but the highest fat (3.87%) and ash (4.81%) contents. These findings are in accordance with those reported by (Abd Elfatah et al., 2019). Overall, the results suggest that lentils are the superior source of protein and fiber, broken rice is the best carbohydrate source, and noodles provide a balanced composition with relatively higher fat and mineral content.

Chemical composition of different dried soup mixtures

Chemical composition of different dried soup mixtures (g/100g) is shown in Table 3. The proximate composition analysis revealed significant differences among the tested samples, particularly regarding protein and carbohydrate levels. Blend L1 exhibited the highest protein concentration (23.52%), suggesting its strong potential for use in nutritionally enhanced food products, which is highly relevant from a nutritional standpoint (FAO/WHO, 2013). Surpassing the control (13.98 %) and other blends (18.60 % in L2 and 17.33 % in L3). Increasing protein content is of high nutritional relevance (FAO/WHO, 2013). The superior protein content of L1 suggests its potential application in the development of nutritionally enhanced food products. In contrast to the control, which had the highest fat content (4.51%), the low-fat composition of L1 (1.00%) aligns with dietary recommendations for reduced lipid intake (Willett et al., 2019), positioning it as a more health-oriented formulation. In contrast, the low-fat composition of L1 (1.00%) combined with its high protein content underscores its superiority as a health-oriented formulation. The carbohydrate content was highest in L3 (72.42%), which corresponded with its lower protein level. Sample L2 exhibited a intermediate macronutrient composition. However, the composition of L1, with its high protein (23.52%), moderate fiber (2.10%), and low fat (1.00%), is considered the most promising, as it directly supports the nutritional strategy of increasing protein density and dietary fiber while reducing fat to improve food functionality (Kumar et al., 2021). Accordingly, the formulation of L1 may contribute to the production of healthier and more functional food products capable of meeting consumer demands for nutrient-dense diets. The caloric analysis of the different samples (Control, L1, L2, and L3) revealed noticeable variations in energy content per 100g. The control sample recorded the highest caloric value (372.55kcal/100g), while the experimental samples exhibited slightly lower values. Among them, L1 (362.04 kcal/100g) and L2 (362.81 kcal/100g) showed the lowest caloric content, whereas L3 (367.10 kcal/100 g) remained closer to the control. The decrease in caloric value observed in the substituted samples (L1, L2, and L3) can be attributed to the higher fat content in the commercial control sample, while the energy obtained in the soup samples prepared from lentils and vegetables came from protein and carbohydrates. Overall, the results indicate that while the control sample delivers the highest energy contribution, the modified formulations L1, L2 and L3 offer reduced caloric values, making them potentially more suitable for health-conscious consumers.

Color of different the dried soup mixtures

Color of different the dried soup mixtures is shown in Table 4. The highest L* value was observed in sample L1 (90.14^{a}), indicating that it is the brightest sample. The lowest L* value was recorded in sample L2 (84.24^{c}), suggesting it is relatively darker. The control sample (7.74^{a}) showed the highest a* value, meaning it has the strongest red hue. Sample L1 (1.28^{d}) had the lowest a* value, indicating less redness. Sample L1 (29.90^{a}) had the highest b* value, which means it is the most yellow among the samples. L3 (24.95^{b}) had the lowest b* value, showing a paler yellow appearance. Control Sample Shows a darker shade with a stronger red component compared to the blends. For a balance between brightness and color intensity, blends L1, L2 and L3 are the best choice. The control sample, although darker and redder, may be preferable in cases where such a color profile is desired.

Table 2. Chemical compositions of the tested raw materials (g\100g)

Sample	Moisture	Protein	Fat	Ash	Crud Fiber	Carbohydrate
Yellow Lintel	$9.49^{a}\pm0.08$	$25.40^{a}\pm0.26$	$1.36^{b}\pm0.14$	$2.61^{b}\pm0.06$	$3.31^{a}\pm0.04$	$57.84^{c}\pm0.25$
Broken rice	$9.71^{a}\pm0.04$	$7.21^{c}\pm0.04$	$0.52^{c}\pm0.01$	$0.54^{c}\pm0.02$	$0.81^{c}\pm0.01$	$81.22^{a}\pm0.06$
Noodles	$5.35^{b}\pm0.26$	$12.08^{b}\pm0.29$	$3.87^{a}\pm0.03$	$4.81^{a}\pm0.17$	$0.90^{b}\pm0.04$	$72.99^{b}\pm0.09$

Data are expressed as means of three replicates ± standard deviation. Values at the same column followed by different superscripts are significantly different ($P \leq 0.05$).

Table 3. Chemical composition of different dried soup mixtures

Sample	Moisture (%)	Protein (%)	Crud Fiber (%)	Fat (%)	Ash (%)	Carbohydrate by difference (%)	Caloric Value (Kcal/100g)
C	$9.51^{a}\pm$ 0.088	$13.98^{d}\pm$ 0.136	$2.02^{a}\pm$ 0.027	$4.51^{a}\pm$ 0.304	$0.97^{b}\pm$ 0.016	$69.01^{c}\pm$ 0.2220	$372.55^{a}\pm$ 0.21
L1	$6.83^{d\pm}+$ 0.074	$23.52^{a}\pm$ 0.058	$2.10^{a}\pm$ 0.114	$1.00^{b}\pm$ 0.042	$1.81^{a}\pm$ 0.042	$64.74^{d}\pm$ 0.154	$362.04^{c}\pm$ 0.06
L2	$8.12^{b}\pm$ 0.022	$18.60^{b}\pm$ 0.075	$1.59^{b}\pm$ 0.200	$1.01^{b}\pm$ 0.050	$0.85^{c}\pm$ 0.009	$69.83^{b}\pm$ 0.335	$362.81^{c}\pm$ 0.09
L3	$7.35^{c}\pm$ 0.091	$17.33^{c}\pm$ 0.089	$1.34^{b}\pm$ 0.120	$0.90^{b}\pm$ 0.044	$0.65^{d}\pm$ 0.0055	$72.42^{a}\pm$ 0.420	$367.1^{b}\pm$ 0.18

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

Table 4. Color of different the dried soup mixtures

Sample	L*	a*	b*
C	$84.58^{c}\pm0.395$	$7.74^{a}\pm0.353$	$26.49^{ab}\pm0.731$
L1	$90.14^{a}\pm0.530$	$1.28^{d}\pm0.086$	$29.9^{b}\pm0.507$
L2	$84.24^{c}\pm0.690$	$2.69^{c}\pm 0.245$	$25.83^{a}\pm0.501$
L3	$88.27^{b}\pm0.149$	$3.19^{b}\pm 0.032$	$24.95^{ab}\pm0.497$

L* = lightness color score are a* = redness color score b* = yellowness color score h = the change of color shad Each mean value, within the same column, followed by the same letters is not significantly different at 0.05 level. (C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

Flavonoid, Total Phenols, Antioxidant Activity (%), and Total Carotenoids of Different Dried Soup Mixtures

The results presented in Table 5 summarize the contents of flavonoids, total phenols, antioxidant activity, and carotenoids in the prepared soup mixtures. The flavonoid content was highest in mixtures L2 and L1, followed by L3, with values of 113.6, 113.0, and 101.3mg/100g, respectively. In contrast, the commercial control sample exhibited the lowest concentration (83.6mg/100g). Similarly, total phenolic content showed a marked increase in samples L1 and L3, followed by L2, compared with the commercial control. This enhancement in phenolic compounds suggests an improvement in the antioxidant capacity of the formulated blends. Antioxidant activity, determined using the DPPH assay, confirmed these results. All formulated soup mixtures exhibited strong antioxidant potential, with L1 showing the highest activity (6.86%) and the control sample the lowest (3.85%). Regarding carotenoid content, the highest concentration was recorded in sample L1 (6.680mg/L), while the lowest was observed in the commercial control (0.726mg/L). A strong positive correlation was observed between total phenolic content and antioxidant activity, indicating that the antioxidant potential of the mixtures is closely associated with their phenolic concentrations, as previously reported by Benvenuti et al. (2004).

Viscosity of Different Dried Soup Mixtures

Understanding the rheological behavior of foods during processing is essential for both process optimization and quality control. Viscosity is a key physical property of liquid and semi-liquid foods, influencing their processing characteristics, texture, and sensory perception. The relationship between viscosity and shear rate allows foods to be classified as Newtonian, non-Newtonian, pseudoplastic, dilatant, thixotropic, or rheopectic. Such classification is highly valuable in processing, quality assurance, sensory evaluation, and structural characterization (Antonio et al., 2009). As shown in Figure 1, the apparent viscosity of the different dried soup mixtures decreased as the shear rate increased. This indicates that all four formulations (Control, L1, L2, and L3) exhibited non-Newtonian pseudoplastic flow behavior. Among the tested samples, soup mixture L1 recorded the highest apparent viscosity (264.96cP), followed by L3 (211.07cP) and L2 (162.78cP), while the commercial control exhibited the lowest value (136.87cP). The relatively lower viscosity of L2 may be attributed to the presence of instant noodles in its formulation, which could influence water absorption and consistency. In the context of soup preparation, viscosity serves as an indicator of thickness and mouthfeel, both of which are critical for consumer acceptability (Ikegwu et al., 2009). The high viscosity observed in L1 can be linked to the functional properties of lentil proteins, which contribute to enhanced water- and fat-binding capacities as well as emulsifying and foaming abilities. These properties are well-documented and have been exploited in the formulation of soups and other food products (Boye et al., 2010).

Table 5. Flavonoids, total phenols, antioxidant activity (%) and total carotenoids of different dried soup mixtures

Sample	Flavonoid (mg quercetin /100g)	Total Phenols (mg GAE /100g)	Antioxidant activity (%)	Total carotenoids (mg/100g)
C	$83.60^{c} \pm 0.025$	$148.30^{c} \pm 0.035$	$3.85^{c} \pm 0.150$	$0.726^{c} \pm 0.115$
L1	$113.00^{a} \pm 0.030$	$214.30^{a} \pm 0.025$	$6.86^{a} \pm 0.350$	$6.680^{a} \pm 2.027$
L2	$113.60^{a} \pm 0.045$	$192.60^{b} \pm 0.035$	$4.47^{b} \pm 0.152$	$3.076^{b} \pm 0.346$
L3	$101.30^{b} \pm 0.025$	$203.60^{a} \pm 0.055$	$4.10^{bc} \pm 0.400$	$3.106^{b} \pm 0.300$

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

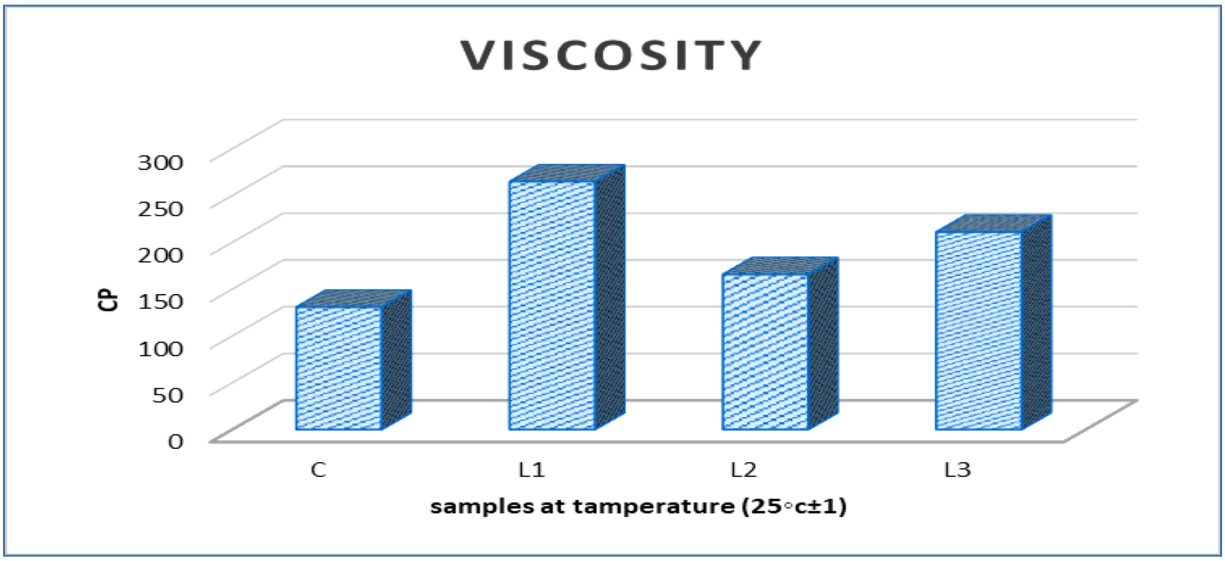

Figure 1. Viscosity of different dried soup mixture

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice

Rehydration Ratio (RR) of the Dried Soup Mixtures

The results presented in Figure 2 illustrate the rehydration ratio (RR) of the dried soup mixtures. The RR values of the formulations containing lentil powder, broken rice, and instant noodles (L1, L2, and L3) were significantly higher 2.80, 2.33 and 2.93, respectively compared with the commercial control sample (1.95). These findings are consistent with those reported by Jokić et al. (2009), who stated that products exhibiting higher rehydration capacity tend to have superior taste and better retention of their fresh-like appearance after preparation.

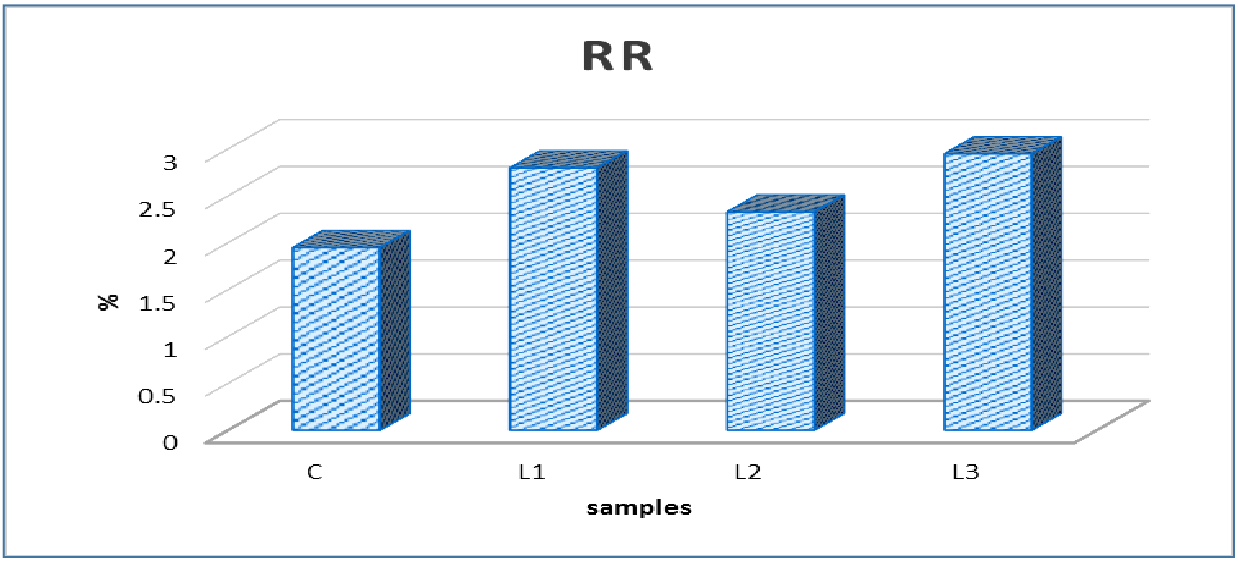

Figure 2. Rehydration Ratio (RR) of different dried soup mixture

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice

Mineral Content of Different Dried Soup Mixtures

Minerals are essential dietary components that play a vital role in numerous biological and metabolic processes, including growth, development, nerve conduction, muscle contraction, energy production, and maintenance of pH and osmotic balance (Chekri et al., 2012). Inadequate or excessive intake of these minerals can lead to nutritional imbalances and associated health problems. Among the physiologically important minerals, calcium (Ca), iron (Fe), and zinc (Zn) are particularly critical for maintaining optimal health. The mineral composition of the dried soup mixtures is presented in Table 6. Samples L1 and L2 showed significantly higher iron contents (3.30–4.33mg/100g) compared with both the control (0.98mg/100g) and L3 (2.50 mg/100g). The highest iron concentration was observed in L2, which contained instant noodles. Lentils are a well-known source of iron, typically ranging between 6–7mg/100g (Ryan et al., 2007), and their inclusion in L1 and L2 likely contributed substantially to the elevated iron levels. The presence of instant noodles in L2 may have further enhanced the iron content, possibly due to flour fortification commonly practiced in the food industry. In contrast, the lower value in L3 is consistent with the low iron content of broken rice, while the very low value in the control sample may reflect differences in lentil variety, formulation ratio, or processing method. Regarding zinc content, dried soup mixture L2 again exhibited the highest concentration (5.34 mg/100 g), significantly exceeding that of all other formulations, including the control (4.10 mg/100g). Samples L1 and L3 showed intermediate and statistically similar values. Lentils generally contain 3–4 mg Zn/100g (Ryan et al., 2007), suggesting that the enhanced zinc content in L2 may result from the synergistic effect of lentils and instant noodles or from fortification of wheat based ingredients. Given the global concern about zinc deficiency, the high zinc level in L2 highlights its potential nutritional benefit (Sohair, 2019). With respect to calcium, mixture L3 exhibited the highest level (74.55 mg/100 g), significantly surpassing all other samples. Calcium fortification is a common practice aimed at improving the nutritional value of foods, particularly those promoting bone health (Beto, 2015). The calcium content of raw lentils is approximately 35mg/100g, whereas polished rice contains only trace amounts (Chekri et al., 2012). The calcium contents observed among the formulated lentil-based soups (58.90–74.55mg/100g) correspond to approximately 5.89–7.46% of the daily calcium requirement for older adults (Sohair, 2019).

Table 6. Minerals content of different dried soup mixtures (mg/100g dry weight)

Samples	Fe	Zn	Ca
C	0.980^{d}±0.05	4.100^{c}±0.1	48.61^{d}±0.01
L1	3.30^{b}±0.05	4.593^{b}±0.045	63.62^{b}±0.02
L2	4.33^{a}±0.02	5.340^{a}±0.02	58.90^{c}±0.03
L3	2.50^{c}±0.03	4.603^{b}±0.065	74.55^{a}±0.05

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

Water activity (aw) of different soup mixtures during the storage period

Water activity (aw) is a key indicator for assessing the stability and safety of dried food products, as it directly influences microbial growth, enzymatic reactions, and chemical degradation (Farzana et al., 2017). A lower a_w value corresponds to reduced microbial activity and an extended product shelf life (Maria et al., 2020). At zero time, all dried soup mixtures exhibited low Aw values ranging between 0.31 and 0.36, confirming sufficient drying suitable for long term storage. Sample L1 recorded the lowest value (0.31), followed by L3 (0.32), L2 (0.34), and the control sample (0.36). These results demonstrate the efficiency of the drying process in the prepared formulations compared to the commercial control. During storage (after 3 and 6 months), all samples exhibited relative stability in aw values, with only minor and statistically insignificant variations. The control sample (C) showed a slight increase in aw after 3 months (0.46) before a small decrease at 6 months (0.44). This fluctuation may be attributed to moisture absorption from the environment due to differences in packaging type or composition. In contrast, L1 and L3 maintained consistently low Aw values (around 0.31 –0.32) throughout the storage period, indicating effective packaging and resistance to moisture uptake. These findings suggest that the formulated dried soup mixtures particularly L1 and L3 outperformed the commercial control sample in maintaining water activity stability. This demonstrates the effectiveness of both the drying technique and the packaging materials used, enhancing the market potential of these products as nutritious, shelf-stable, and high quality alternatives

Table 7. Water activity (aw) of different soup mixtures during the storage period

Samples	Water Activity		
	zero time	After 3 months	After 6 months
C	0.36^{a} ± 0.003	0.46^{a} ± 0.012	0.44^{a}± 0.002
L1	0.31^{c} ±0.010	0.29^{c} ± 0.003	0.31^{c} ± 0.010
L2	0.34^{b}± 0.001	0.32^{b} ± 0.001	0.34^{b} ± 0.001
L3	0.32^{c} ± 0.006	0.31^{b}±0.001	0.32^{c} ± 0.006

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

Sensory Evaluation of Different Dried Soup Mixtures

The sensory evaluation of the control sample (C) and the dried soup mixtures (L1, L2, and L3) was conducted at three storage intervals: zero time, 3 months, and 6 months, as shown in Table 8. The evaluated attributes included color, taste, aroma, flavor, and overall acceptability. At zero time, significant differences ($p < 0.05$) were observed among treatments. Dried soup mixture L1 achieved the highest scores across all sensory attributes color (9.00), taste (8.83), aroma (8.93), flavor (8.83), and total acceptability (8.83) followed by L2 and L3, while the control sample recorded the lowest scores (7.33 for total acceptability). These findings indicate that L1 was the most preferred soup mixture in its fresh state. After 3 months of storage, a general decline in sensory scores was observed across all samples, which is expected due to storage effects. However, L1 maintained its superiority with the highest overall acceptability (8.33), followed by L2 (7.83) and L3 (7.67), whereas the control sample had the lowest score (7.17). L1 thus remained the most acceptable formulation after 3 months. Following 6 months of storage, a further reduction in sensory scores occurred for all samples. Nevertheless, L1 and L2 maintained relatively higher overall acceptability (7.53 each) compared to L3 (7.20) and the control (6.67). Although the difference between L1 and L2 became narrower, both retained stable and acceptable sensory quality, outperforming the other samples. Therefore, L1 can be recommended as the optimal dried soup formulation, with L2 also demonstrating good sensory stability during extended storage. Overall, the sensory quality of all soup samples remained satisfactory throughout the storage period. The inclusion of lentils was the most beneficial factor contributing to improved sensory attributes and consumer acceptance. These findings are consistent with those reported by Taiba et al. (2022) and Panagiota et al. (2022), who emphasized the importance of developing nutrient-rich, legume-enriched cereal-based products to increase legume consumption and promote public health.

Table 8. Sensory evaluation of different dried soup mixtures

Storage period	Sample	Color (9)	Taste (9)	Aroma (9)	Flavor (9)	Overall acceptability (9)
Zero time	C	7.00^{b}±1.00	7.00^{b}±1.00	7.00^{b}±1.00	7.00^{b}±1.00	6.67^{b}± 0.58
	L1	9.00^{a}±0.00	8.67^{a}±0.57	8.33^{a}±0.57	8.33^{b}± 0.58	9.00^{a}±0.00
	L2	8.67^{a}±0.57	7.67^{ab}±0.57	8.33^{a}± 0.57	8.67^{a}± 0.58	8.67^{a} ±0.58
	L3	8.33^{a}±0.57	7.67^{ab} ± 0.57	8.00^{ab}±0.00	8.33^{ab}± 0.58	8.66^{a} ± 0.58
After 3 months	C	6.67^{b}±0.577	7.00^{b}±0.00	7.33^{a}±0.577	7.00^{a}±0.50	7.33^{b}±0.577
	L1	8.33^{a}±0.577	8.00^{a}± 0.00	8.00^{a} ±0.00	7.83^{a} ± 0.288	8.50^{a} ±0.100
	L2	8.00^{a}± 0.00	7.33^{ab}±0.577	7.67^{a}±1.154	7.83^{a}±0.763	8.17^{ab}±0.763
	L3	8.333^{a} ±0.577	7.67^{ab}±0.577	8.00^{a}±1.00	7.83^{a}±0.763	8.50^{a}± 0.500
After 6 months	C	6.33^{a}±1.154	6.33^{a}±1.154	6.00^{a}±1.000	6.33^{a}±2.081	6.33^{a}± 1.154
	L1	8.00^{a}±1.00	7.67^{a}±1.527	8.00^{a}±1.732	8.00^{a}± 1.732	8.00^{a}±1.732
	L2	7.67^{a}±1.527	8.00^{a}±1.00	7.67^{a}±0.577	8.00^{a}± 1.00	8.00^{a} ±1.00
	L3	8.33^{a}±0.577	7.33^{a}± 0.577	7.33^{a}±0.577	7.67^{a}± 0.577	7.67^{a}±0.577

(C) The commercial control, (L1) dried lentil soup+ dried vegetables, (L2) dried lentil soup + noodles, (L3) dried lentil soup+ broken rice. Values are mean of three replicates followed by ± SD, the number at the same row followed by the same letter are not significantly different at $p \leq 0.05$.

4. Conclusion

The superior sensory acceptability and higher apparent viscosity observed in formulation L1 can be principally attributed to its elevated protein content and rich carotenoid and phenolic profile. Increased protein concentration enhances water-binding capacity and promotes formation of a continuous protein matrix upon rehydration, thereby increasing soup thickness and mouthfeel. Concurrently, high levels of phenolics and carotenoids in L1 likely contributed to oxidative protection of lipids and pigments, preserving color and flavor during storage. By contrast, L2 although rich in iron and zinc may carry a higher pro-oxidant risk due to iron's catalytic role in lipid oxidation; however, its phenolic content appears to partially counteract this effect, resulting in acceptable sensory stability. The low and stable water activity values measured for L1 and L3 further limit oxidative and enzymatic degradation, reinforcing the observed shelf-life. Together, these compositional-functional relationships explain why L1 attains the best balance of nutritional quality, functional properties, and shelf stability.

References

Abd Elfatah, M.A., El-kalyoubi, M.H., Mostafa, M.M. and Ashoush, I.S. (2019). Development and evaluation of noodles prepared from rice and wheat flour blends. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, Egypt, 27(2):1483 -1489.

Amal, M.H. Abdel-Haleem, and Azza, A. Omran. (2014). Preparation of Dried Veterinarian Soup Supplemented With Some Legumes. Food and Nutrition Science, 5, 2274-2285.

Antonio, G.C., Faria, F.R., Takeiti, C.Y. and Park, K.J. (2009). Rheological Behavior of Blueberry. Ciênc Tecnology Aliment Campinas, 29, 732-737. doi.org/10.1590/S0101-20612009000400006

AOAC (2019). Association of Official Analytical Chemists, AOAC International 21st edition Association of Official Analytical Chemists. Washington, D.C. Available from https://www.aoac.org/official-methods-ofanalysis-21st edition-2019.

Ayman, M.A., Mohamed, A.A.N., Ragab, A.E. and Mona, A.M.H. (2019). Chemical and Sensory Properties of Black Rice Compared with Giza 177Rice Cultivar. Alexandria science exchange journal, 40(4):576-584.

Benvenuti S, Pellati F, Melegari M, and Bertelli D (2004). Polyphenols, anthocyanins, ascorbic acid, and a radical scavenging acitivity of Rubus, Ribes and Aronia. Food and Chemical Toxicology, 69:164-169.

Beto, J.A. (2015). The Role of Calcium in Human. Aging. Clin. Nutr. Res., 4:1-8.

Boye, J., Zare, F. and Pletch, A. (2010). Pulse Proteins: Processing, Characterization, Functional Properties and Applications in Food and Feed. Food Research International, 43, 414-431. http://dx.doi.org/10.1016/j.foodres.2009.09.003

Brookfield Manual (1998). Brookfield Manual Operating Instruction. No. M/98-211-B0104. Brookfield Engineering Laboratories Inc., Middleborough

Cadden, A.M. (1988). Moisture Sorption Characteristics of Several Food Fibers. Journal of Food Science 53(4):1150-1155.

Cecil, J.E., Francis, J. and Read, N.W. (1999). Comparison of the effects of a high-fat and high -carbohydrate soup delivered orally and intragastric ally on gastric emptying, appetite, and eating behavior. Physiology and Behavior 67(2): 299-306.

Chekri, R., Laurent, N, Milloura, Vastel, S. and Kadar, C.A. (2012). Calcium, magnesium, sodium and potassium levels in foodstuffs from the second French total diet study. J. Food Compos. Anal., 25, 97-107.

Childs, N.W. (2020). Department of Agriculture, Economic Research Service. U.S. Rice Production Forecast for 2020/21 Raised to 225.0

Daniel, R.P., Elena, C.G. María, K. Dilip, C.M., Rai, F. Juana and Ana, B.M. (2021). Development of Antioxidant and Nutritious Lentil (Lens culinaris) Flour Using Controlled Optimized Germination as a Bioprocess. Foods, 10 (12):2924-2947.

FAO/WHO. (2013). Dietary protein quality evaluation in human nutrition. Report of an FAO Expert Consultation. FAO Food and Nutrition Paper 92.

Farzana, T., Mohajan, S., Saha T., Hossain, M.N. and Haque, M.Z. (2017). Formulation and nutritional evaluation of a healthy vegetable soup powder supplemented with soy flour, mushroom, and moringa leaf. Food Sci. Nutr., 5(4):911–920. doi: 10.1002/fsn3.476.

Holm, G. (1954). Chlorophyll mutations in barley. Acta. Agric. Scand., 4(1):457-471.

Hwang, E.S. and Do Thi, N. (2014). Effects of Extraction and Processing Methods on Antioxidant Compound Contents and Radical Scavenging Activities of Laver (*Porphyra tenera*). Preventive Nutrition and Food Science, 19:40-48.

Ikegwu, O.J., Oledinma, N.U., Nwobasi, V.N. and Alaka, I.C. (2009). Effect of Processing Time and Some Additives on the Apparent Viscosity of "Achi" Brachystegia eurycoma Flour. Journal of Food Technology, **7**, 34-37.

James, C.S. (1995). General Food Studies. In: Analytical Chemistry of Foods, Chapter 6, Blachie Academic and Professional, pp: 137-171.

Jia, Z., Tang, M. and Wu, J. (1999). The determination of flavonoid content in mulberry and their scavenging effects on superoxide radicals. Food Chemistry, 64:555–559.

Jokić, S., Mujić, I., Martinov, M., Velić, D., Bilić, M. and Lukinacc, J. (2009). Influence of Drying

Procedure on Color and Rehydration Characteristic of Wild Asparagus. Czech Journal of Food Science 27(3):171-177.

Joshi, M., Timilsena, Y. and Adhikari, B. (2017). Global production, processing and utilization of lentil: A review. Journal of Integrative Agriculture 16(12):2898-2913.

Krishan, D., Sharma, S., Karki, N., Singh, T. and Surekha, A. (2012). Chemical composition, functional properties and processing of carrot a review. Journal of food Science and Technology, 49(1):22–32. DOI:10.1007/s1319701103107

Krokida, M.K. and Marinos-Kouris, D. (2003). Rehydration Kinetics of Dehydrated Products. Journal of Food Engineering, 57(1):1-7.

Kumar, M., Tomar, M., Potkule, J., Verma, R., Punia, S., Mahapatra, A. and Singh, S. (2021). Functional characterization of plant-based protein hydrolysates and their application in food and nutraceuticals. Food Science and Human Wellness, 10(2):120–133.

Maria, S. Taapia, Stella Alzamora and Jorrge Chirife. (2020). Effect of Water Activity (a_w) on Microbial Stability as a Hurdle in book Water activity in Foods (pp: 323-355).

Mc- Gurie, R.G. (1992). Reporting of Objective Color Measurements. Hort Science, 27:1254-1255.

Monteiro, M.L.G., Mrsico, E.T. and Lzaro, C.A. (2014). Flours and Instant Soup from Tilapia Wastes as Healthy Alternatives to the Food Industry. Food Science and Technology Research 20:571-581.

Nermin B. (2013). Some chemical and sensory properties of gluten-free noodle prepared with different legume, pseudocereal and cereal flour blends. J. of Food and Nutrition Research, 52(4): 251-255.

Panagiota, B., Amalia E.Y. and Vaios, T.K., (2022). Physical properties, sensory acceptance, postprandial glycemic response, and satiety of cereal based foods enriched with legume flours. Crit Rev Food Sci Nutr., 62(10):2722-2740. doi: 10.1080/10408398.2020.1858020.

Payman, M.H., Bagheri, I., Alizadeh, M.R. and Roohi, R. (2006). Effective parameters of broken rice during paddy hulling using rubber roll huller, Journal of Biological Science, 7, 45−71.

Rekha, M.N.A., Yadav, R., Dharmesh, S., Chauhan, A.S. and Ramteke, R.S. (2010). Evaluation of Antioxidant Properties of Dry Soup Mix Extracts Containing Dill (*Anethum sowa* L.) Leaf. Food and Bioprocess Technology, 3, 441-449. http://dx.doi.org/10.1007/s11947-008-0123-5.

Ryan, E., Galvin, K., Connor, T.P.O., Maguire, A.R. and Brien, N.M.O. (2007). Phytosterol, squalene, tocopherol content and fatty acid, profile of selected seeds, grains, and legumes. Plant Foods Hum Nutr. 62: 85-91.

Sohair, T.E. (2019). The Nutritional Value of Improving Dried Lentil Soup. Food Sci. Nutr. and Technol. 4(5):1-14. DOI:10.23880fsnt16000192.

Steel, R.G.D., Torrie, J.H. and Dicky, D.A. (1997). Principles and Procedures of Statistics: A Biometrical Approach. 3rd, Edition, McGraw Hill, Inc. Book Co., New York, 352-358.

Taiba, U., Ali, A., Ali, A., Azam, I., Israr, A., Ilyas, A., Fatima, A., and Hameed, Z. (2022). Development and quality evaluation of dried vegetable soup added with some legumes. International Journal of Health Sciences, 6(S7):49035–49062.

Wang, R., Zhang, M., Mujumdar A.S. and Sun, J.C. (2009). Microwave Freeze-Drying Characteristics and Sensory Quality of Instant Vegetable Soup. Drying Technology, 27:962-968.

Wettstein, D.V. (1957). Chlorophyll –letale und sub -mikroskopishe form weschselder plastiden. Experimental Cell Research, 12(3):427–506.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S. and Murray, C.J.L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet, 393 (10170):447–492.

Zilic, S., Serpen, A., Akillioglu, G., Jankovic, M. and Gokmen, V. (2012). Distributions of phenolic compounds, yellow pigments and oxidative enzymes in wheat grains and their relation to the antioxidant capacity of bran and debranned flour. Journal of Cereal Science, 56:652-658.