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Enhancement of Nutritional Profile, Rheological and Quality Features of Wheat Flour Biscuits Supplemented with Lentil-oat Flour

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Abstract. Malnutrition is most prevalent in the children particularly in developing countries like Pakistan. Statistics have revealed a horrible picture about children suffering from Protein Energy Malnutrition (PEM) and micronutrient deficiencies. Nonetheless, there is burgeoning demand for nutrient dense foods. In this perspective, nutritional value of the biscuits was enhanced by supplementing wheat flour with lentil and oat flour (5, 10, 15, 20 and 25%). Chemical composition of different flours indicated that oat flour had higher ash and fiber content, whereas highest fat and protein were reckoned in lentil flour. The composite flour (WF: LF: OF; 50: 25: 25) showed highest concentrations of nutrients like ash (3.76%), fat (4.09%), fiber (2.96%) and protein (12.50%). Addition of supplement flour shad significantly affected the dough rheological properties. Nutrient composition of lentil-oat supplemented biscuits evaluated in terms of moisture (3.22-4.30%), ash (0.45-1.71%), fat (19.71-27.40%), fiber (0.20-2.56%) and protein (5.44-8.90%), carbohydrate (56.64-69.80%), iron (3.3-5.90 mg/100g), zinc (0.56-3.59 mg/100g) and energy value (528.26-588.76 Kcal). Spread factor of such biscuits varied between 45.90 and 56.00. The highest acceptability for biscuits was observed when wheat flour was supplemented with lentil and oat flour at 15% level.

Keywords: oat flour, lentil flour, supplementation, nutrition, biscuits

Introduction

In Pakistan, malnutrition including macro and micro-nutrient deficiencies caused a great menace for the population. Apart from the malnutrition, today's lifestyle exposed the children to junk food, which is primarily low in nutrients. Protein Energy Malnutrition (PEM) is a major health concern in developing countries particularly rural areas (Meité *et al*., 2008). Moreover, it may cause marasmus, kwashiorkor and immune deficiencies and is triggered by various factors, the foremost being the deficiency of protein intake (Burgess, 2005). Consequently, fortification of staple foods with the food materials containing higher protein and micro-nutrients, represents the most effective strategy to enhance nutritional status of rural areas in developing countries (OMS, UNICEF, 2007; Serna-Sadivar *et al*., 1999).

More than 30 percent of world's population is suffering from micronutrient deficiency. Zinc is an important trace metal, which is imperative for growth and development. In Pakistan, zinc deficiency is a rising health concern since about 20.6% youngsters were found to have zinc levels underneath 60 μg/dL. Symptoms of zinc deficiency include hunger, weight reduction and poor development in adolescence, taste glitches and mental laziness. Iron deficiency causes anemia which is very severe health issue and faced by major population of the world. Children and women are main victims of anemia especially of poor families due to low quality of diet. Iron deficiency in children retards development both physical and physiological, reduced immunity and laziness. The most inexpensive method to control iron deficiency is supplementation or fortification of food with iron rich sources. In this regard, use of local nutrient rich ingredients in food products instead of food supplements are economical and healthy.

Legumes represent the second largest food source for human beings (Berrios, 2006), which significantly contribute to the improvement of PEM (Kudre *et al*., 2013). Moreover, human ought to depend on legume protein to encounter their diet requirement of protein (Sibt-e-Abbas *et al*., 2015). Lentil is a leguminous crop that contains higher levels of protein, dietary fiber, complex carbohydrates, mineral and vitamins (Küçükçetin *et al*., 2012; Costa *et al*., 2006). Due to

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high dietetic value, these are considered as one of the most imperative pulse crops worldwide. The incorporation of lentil into cereal-based products might be effective to improve the intake of such products. Earlier, lentil flour was used in preparing cakes (Koubaier *et al*., 2015). Moreover, biscuits prepared by supplementing wheat flour with lentil flour contained significantly highest mineral content (Awad El kareem and Al-Shammari, 2015).

Oat naturally contains high levels of health promoting components like proteins, soluble fiber, unsaturated fatty acids, minerals, vitamins and phytochemicals (Flander *et al*., 2008). It has been reported that oat flour contains much higher protein as compared to wheat, rice, maize, rye, barley and sorghum. Recently, oat has been utilized in the fortification of food products owing to its superior nutrition particularly, higher dietary fiber, vitamin and minerals (Rasane *et al*., 2015). Noodles with high nutritive value were prepared by incorporating of oat flour (20%) without affecting the overall quality (Kudake *et al*., 2017). In addition, bread with acceptable quality was prepared by the replacement of wheat flour with oat flour and contained higher nutritional value particularly in fiber, protein and iron content (Shrestha *et al*., 2013).

Among bakery products, biscuits contain low moisture, which enable microbiologically more stable. Moreover, these serve as a considerable energy source and are consumed all over the world (Ullah *et al*., 2016; Arshad *et al*., 2007). Apart from popularity of biscuits in all age groups, the inferior protein quality of refined wheat flour has been critical issue regarding their utilization. Nonetheless, protein deficiency may be addressed by protein-rich non-wheat flour supplementation such as legumes with superior nutritional quality (Ullah *et al*., 2016; Shalini and Sudesh, 2005).

Composite flour is an efficient approach for the utilization of uncommon food sources since, the application of composite flours developed the products with different quality characteristics, depending upon type and proportion of wheat flour in the preparation (Noorfarahzilah *et al*., 2014). Efforts have been made in past for the successive utilization of different types of composite flours for the development of bread (Asta *et al*., 2013; Ho *et al*., 2013), cookies (Cheng and Bhat, 2016; Zouari *et al*., 2016) and pasta (Seczyk *et al*., 2016). No literature has been found on the development of biscuits form the wheat flour supplemented with lentil-oat flour. In this backdrop, the main aim of this study was to formulate a composite flour of wheat, lentil and oat flours and to evaluate its impact on quality characteristics of dough and nutritional value of biscuits.

Materials and Methods

Materials. Wheat, lentil and oat grains were procured from Food Science and Products Development Institute (FSPDI) Research Lab., National Agriculture Research Centre (NARC) Islamabad-Pakistan. All the chemicals were purchased from Merck (Germany) as well as local market.

Milling of wheat and oat grains. Wheat and oat grains were milled in grain milling machine (Model # MJ-J176P) in the Grain Milling Laboratory of NARC to produce fine wheat flour and oat flour.

Preparation of lentil flour. To remove the impurities, the lentil seeds were sorted and washed with tap water. After that, seeds were spread on metal tray and dried in a vacuum-oven at 45 °C for 72 h. Seeds were ground and passed through two sifters to produce fine flour.

Preparation of composite flour. Wheat flour was supplemented with lentil and oat flour at different levels i.e. 5, 10, 15, 20 and 25%, which were selected based on preliminary sensory trials performed for wheat based biscuits supplemented with various proportions of lentil and oat flours. Oat flour was chosen as it is rich in minerals especially iron and zinc along with the other nutrients and is rich in fiber, while lentil is also nutrient rich and is good source of protein and lysine.

Chemical analyses of different flour. Chemical composition of different flour samples was determined *viz*. moisture (method No. 925.10; AOAC, 2005), ash (method No. 923.03; AACC, 2000), fat (method No. 203.06; AOAC, 2005), fiber (method No. 32-10; AACC, 2000) and protein content (method No. 46-10; AACC, 2000) according to their respective methods. Moreover, total carbohydrates were calculated by the following formula:

Total carbohydrates (%) = 100% - (% moisture + % ash + % crude lipid + % crude fiber + % crude protein)

Farinographic characteristics of composite flour dough. The effect of supplementation of lentil and oat flours on dough rheology of wheat flour was determined by using a Brabender farino graph (Wang *et al*., 2002). The parameters measured were water absorption (WA), dough development time (DDT), departure time (DT), mixing tolerance index (MTI), dough stability (DS) and farinograph quality number (FQN).

Preparation of biscuits. Composite flour was utilized for the preparation of biscuit by following the method no. 10.52 as described in AACC (2000). Biscuits were baked at 180 °C for 12 min and then cooled at room temperature for 20 min Biscuits were packed in polyethylene sealed pouches for further analysis

Nutritional quality of biscuits. Chemical composition of prepared biscuits was estimated by the standard methods as mentioned for chemical analyses of different flour. Iron and zinc content of wheat-lentil-oat composite biscuits were estimated through Atomic Absorption Spectrophotometer (AAS) according to the method of Skrbic and Cupic (2005). Energy value (Kcal) of wheat-lentil-oat composite biscuits was calculated by following formula:

Energy value = (% protein × 4) + (% pipid × 9) + (% carbohydrate × 4).

Sensory evaluation of biscuits. Sensory attributes of biscuits were evaluated by using 9-point hedonic score system where 9 extremely liked and 1 extremely disliked (Larmond, 1997). The samples were evaluated for their organoleptic characteristics. The sensory evaluation was done by a panel of 20 judges who were trained properly how to evaluate samples. All the samples which were coded were provided to each panelist. The panelists were also provided with water to take after each sample to refresh their taste. This evaluation activity was used to select best formulation for biscuits.

Spread factor. Spread factor of biscuits was calculated by the following formula as given in AACC (2000).

Spread factor = (width/thickness) × correction factor × 10

Correction factor was 1 at atmospheric pressure.

Statistical analysis. All the experiments were carried out in triplicates and data were evaluated by analysis of variance (ANOVA) using Statistix 8. Means were compared using least significant difference at the 0.05 level of probability (Steel *et al*., 1997).

Results and Discussion

Chemical composition of different flour samples. Data regarding chemical composition of wheat flour, lentil flour and oat flour is given in Table 1. It is obvious that, wheat flour contained significantly (P<0.05) highest moisture content (14.33%) as compared to lentil and oat flour (10.64% and 12.51%, respectively), however protein content was reckoned highest in lentil flour (25.09%) as compared to its levels in oat flour (10.60%) and wheat flour (7.46%). Present findings were commensurate to values observed by Koubaier *et al.* (2015), who reported 14.60% moisture content in wheat flour and 25.51% protein content in lentil flour. In another study, conducted by Sterna *et al.* (2016), protein content of oat flour was found in the range of 9.7-17.3%.

In the present investigation, fat content was higher in lentil flour (7.26%) than those in oat (6.53%) and wheat flour (0.69%). The results regarding fat content of oat flour agreed with Sterna *et al.* (2016) and Fistes *et al.* (2014), who reported fat content of oat flour as 6.45% and 5.2-12.4%, respectively. Ash and fiber contents were observed higher in oat flour (3.80 and 6.42%, respectively) compared to lentil (3.70 and 4.80%, respectively) and wheat flour (0.58 and 0.53%, respectively). These results were consistent with the observations of Sandhu *et al.* (2017) who reported ash content of oat flour in the range of 2.60-3.90%. Compositional analysis of different types of flour revealed that wheat flour contained highest total carbohydrate content (76.41%) followed by oat (60.14%) and lentil flour (48.51%). Several publications have explored the nutritional potential of legumes as a protein rich ingredient for baked products (Kadam *et al*., 2012; Des-Marchais *et al*., 2011; Tiwari *et al*., 2011).

Table 1. Chemical composition of wheat, lentil and oat flours

Flour samples	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	Protein (%)	Total carbohydrate (%)	Iron (mg/100g)	Zn (mg/100g)
Wheat flour	14.33 ± 0.64^{a}	0.58 ± 0.02^{b}	0.69 ± 0.03^{c}	0.53 ± 0.02^{c}	7.46 ± 0.33^{c}	76.41 ± 3.43^{a}	3.30 ± 0.03^{c}	0.60 ± 0.06^{c}
Lentil flour	10.64 ± 0.48^{c}	3.70 ± 0.17^{a}	7.26 ± 0.33^{a}	4.80 ± 0.22^{b}	25.09 ± 1.15^{a}	48.51 ± 2.23^{c}	5.33 ± 0.01^{a}	4.50 ± 0.12^{a}
Oat flour	12.51 ± 0.58^{b}	3.80 ± 0.17^{a}	6.53 ± 0.31^{b}	6.42 ± 0.30^{a}	10.60 ± 0.49^{b}	60.14 ± 2.82^{b}	4.0 ± 0.11^{b}	3.20 ± 0.04^{b}

Values are represented as means of three observations±standard deviation. Mean values carrying different superscripts in a column are statistically significant (P≤0.05).

Chemical composition of composite flour. Table 2 illustrates the mean effects of the addition of lentil and oat flour on the studied parameters of wheat flour. A significant (P<0.05) decrease in moisture content of flour was observed from 14.33% to 13.08% with the addition of lentil and oat flour. Similarly, an ascending trend was noted for ash content of flour, as the proportion of lentil and oat flour increased. Within treatments, composite flour containing 25% of lentil and oat flour possessed highest fat content (4.09%).Addition of lentil and oat flour at various concentrations positively affected the fiber content of composite flour and it ranged between 0.53 and 2.96%. Protein content of composite flour containing different level of lentil and oat flour were observed as 7.46, 8.45, 9.50, 10.59, 11.20 and 12.50%, respectively. A descent trend from 76.10 to 65.25% was observed for total carbohydrate content of composite flour with varying concentrations of lentil and oat flour (Table 2). This may possibly be because increasing levels of lentil and oat flour resulted in increase in other nutrients of flour, entailing fat, fiber and protein content. Shahzadi *et al.* (2005a) reported that moisture and fat content were decreased after incorporation of lentil flour whereas, the flour resulted in higher ash, fiber and protein content.

Rheological properties of composite flour. Representative mean values for the rheological parameters of investigated composite flour samples are presented in Table 3. Increasing the substitution level of lentil and oat flour significantly improved the water absorption of composite flour from 54.20 to 63.30%. The increase in water absorption by adding lentil flour might be explained by the fact that lentil flour had higher levels of protein, starch and fiber and all these constituents compete for retaining water during dough making (Dhinda *et al*., 2012; Gimenez *et al*., 2012). Present findings were commensurate to work of Kohajdová *et al.* (2013), who have reported significant increment in water absorption of wheat flour following the addition of legume flour.

Similarly, dough development and departure time were elevated in response to the addition of varying levels of lentil and oat flour. The longer duration of dough development might be due to the interactions between gluten and non-wheat proteins, which led to a deferment in hydration and gluten development because of these constituents (Dhinda *et al*., 2012).

Within treatments, an assorted trend was observed for mixing tolerance index as T_6 (WF:LF:OF; 50:25:25)

Table 2. Chemical composition of composite flours

Treatments	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	Protein (%)	Total carbohydrate (%)	Zinc (mg/100g)	Iron (mg/100g)
T_1 (WF; 100)	14.33±0.64^{a}	0.58±0.02^{f}	0.69±0.03^{f}	0.53±002^{e}	7.46±0.33^{f}	76.10±3.43^{a}	0.60±0.06^{c}	3.21± 0.16^{f}
T_2 (WF:LF:OF; 90:5:5)	13.85±0.63^{b}	0.86±0.04^{e}	1.60±0.07^{e}	1.02±0.04^{d}	8.45±0.38^{e}	74.22±3.41^{b}	1.09±0.09^{c}	3.74± 0.04^{e}
T_3 (WF:LF:OF; 80:10:10)	13.72±0.64^{c}	1.54±0.05^{d}	2.26±0.106^{d}	1.61±0.07^{c}	9.50±0.44^{d}	71.77±3.37^{c}	2.13±0.01^{c}	4.37± 0.01^{d}
T_4 (WF:LF:OF; 70:15:15)	13.64±0.66^{d}	2.48±0.07^{c}	2.80±0.13^{c}	1.60±0.07^{c}	10.59±0.51^{d}	69.89±3.45^{d}	2.52±0.02^{c}	4.78 ± 0.02^{c}
T_5 (WF:LF:OF; 60:20:20)	13.40±0.54^{e}	3.23±0.06^{b}	3.40±0.14^{b}	2.42±0.09^{b}	11.20±0.45^{b}	67.89±2.78^{e}	4.04±0.06^{c}	5.20± 0.18^{b}
T_6 (WF:LF:OF; 50:25:25)	13.08±0.56^{f}	3.76±0.09^{a}	4.09±0.17^{a}	2.96±0.12^{a}	12.50±0.53^{a}	65.25±2.81^{f}	5.09±0.01^{c}	5.90± 0.03^{a}

Values are represented as means of three observations±standard deviation. Mean values carrying different superscripts in a column are statistically significant (P≤0.05).WF=Wheat flour; LF=Lentil flour; OF=Oat flour.

Table 3. Physical dough properties of composite flours

Treatments	Wet gluten	Dry gluten	WA	DDT (min)	DT (min)	MTI (min)	DS (min)	FQN
T_1(WF; 100)	22.30±1.01^{a}	8.20±0.36^{a}	54.20±2.43^{d}	1.33±0.06^{c}	2.60±0.11^{d}	64.00±2.88^{e}	3.50±0.15^{a}	26.00±1.17^{d}
T_2(WF:LF:OF; 90:5:5)	25.00±1.15^{a}	6.80±0.31^{b}	54.53±2.51^{d}	1.50±0.06^{c}	2.80±0.12^{d}	33.00±1.51^{e}	1.10±0.05^{b}	28.00±1.28^{d}
T_3(WF:LF:OF; 80:10:10)	17.50±0.82^{b}	5.80±0.27^{c}	59.30±2.78^{c}	2.20±0.10^{b}	3.30±0.15^{c}	33.00±1.55^{d}	0.70±0.03^{c}	33.00±1.55^{c}
T_4(WF:LF:OF; 70:15:15)	16.50±0.80^{c}	5.50±0.27^{d}	60.20±2.95^{b}	2.20±0.10^{b}	3.40±0.16^{c}	40.00±1.96^{c}	0.40±0.02^{c}	33.66±1.64^{c}
T_5(WF:LF:OF; 60:20:20)	15.30±0.62^{d}	4.60±0.18^{e}	60.40±2.47^{b}	4.50±0.18^{a}	5.86±0.24^{b}	78.00±3.19^{b}	0.40±0.01^{d}	59.00±2.41^{b}
T_6(WF:LF:OF; 50:25:25)	14.37±0.61^{e}	3.80±0.16^{f}	63.30±2.72^{a}	4.70±0.20^{a}	7.10±0.30^{a}	93.00±3.99^{a}	0.10±0.004^{d}	71.00±3.05^{a}

Values are represented as means of three observations±standard deviation. Mean values carrying different superscripts in a column are statistically significant (P≤0.05).WA=Water absorption; DDT=Dough development time; DT=Departure time; DS=Dough stability; FQN=Farinograph quality number yielded highest value (93.00 min), whereas T_2 and T_3 had lowest (33.00 min), while Farinograph quality number increased with increasing levels of substitution of lentil and oat flour. Substitution of lentil and oat flours into wheat dough considerably reduced dough stability, particularly at greater substitution levels. Similar observations were also made by Gimenez *et al.* (2012) and Shahzadi *et al.* (2005b), they observed a decrease in dough stability for wheat doughs by increasing the levels of different legume flours. A possible explanation for the decrease may be the reduction in gluten content of wheat flour (Shahzadi *et al*., 2005b).

Nutrient composition of wheat lentil oat biscuits. Table 4 shows mean effects of supplementation of lentil and oat flour on the nutrient composition of wheat lentil oat supplemented biscuits. Data showed a significant ($P<0.05$) reduction in moisture content of biscuits from 4.30 to 3.22%. Statistical data regarding ash content of biscuits produced with the addition of lentil and oat flour portrayed that treatments caused a significant increase (0.45 to 1.71%) in ash content of biscuits. The treatment containing wheat lentil oat (50:25:25) revealed maximum fat content (27.40%), However, T_o had lowest fat content (19.71%), this is due to the presence of higher fat content in lentil and oat flour as compared to wheat flour. The fat content of prepared biscuits decreased with an increase in the storage interval.

The supplementation had significantly increased the fiber content of biscuits with increased addition of lentil and oat flour (0.20% to 2.56%) (Table 4). Protein content in biscuits was found as 5.44, 6.57, 6.75, 6.96, 7.66 and 8.90% with increase in amount of supplement flours. The higher protein content of lentil flour might be the main reason for higher protein content of biscuits. This might be explicated owing to Maillard reaction between amino acids and reducing sugars, which was the main reason of degradation of nutritional value of several food products including the impairment of the nutritional value of protein and loss of stability (Fennema, 1996). A decreasing trend from 69.80 to 56.64% was observed for carbohydrate content of biscuits supplemented with varying levels of lentil and oat flour.

The supplementation of varying levels of lentil and oat positively affected iron content of biscuits from 3.30 mg/100g to 5.90 mg/100g. Deficiency of iron is the most important nutritional concern all over the world and have attained the epidemic level in different developing countries as stated earlier (Sirdah *et al*., 2014). Likewise, results regarding mineral content of biscuits made with the addition of lentil and oat flour portrayed a significant impact of treatments on zinc content of biscuits and a gradual increase was observed from 0.56 to 3.59 mg/100g. Figure 1 illustrates energy values of wheat lentil oat composite biscuits. Treatment (50:25:25) possessed significantly ($P<0.05$) greater energy value (588.76 Kcal) than other treatments. These results are also justified by the work of Ullah *et al.* (2016), who observed that nutrient content of biscuits supplemented with alfalfa seed flour were significantly ($P<0.05$) increased with the gradual increase in level of supplementation.

Quality characteristics of biscuits made with lentil oat supplemented flour. Figure 2 shows that the spread factor progressively declined from 56.00 to 45.90 with increasing levels of lentil and oat flour. Generally, this reduction in spread factor was related to increasing level of fiber and protein. Present findings are in close agreement with Awan *et al.* (1995) who interpreted a decrease in the spread factor of biscuits because of increase supplementation of moth bean flour in composite flour. Higher levels of protein, starch damage

Table 4. Nutrient composition (%) of wheat-based biscuits supplemented with lentil and oats

Treatments	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	Protein (%)	Total Carbohydrates (%)	Iron (mg/100g)	Zinc (mg/100g)
T_1	4.30±0.19^{efg}	0.45±0.02^{t}	19.71±0.88^{m}	0.20±0.01^{h}	5.44±0.25^{x}	69.80±3.14^{c}	3.30±0.14^{i}	0.56±0.02^{g}
T_2	4.01±0.18^{hij}	0.71±0.03^{o}	21.29±0.97^{j}	0.68±0.03^{f}	6.57±0.30^{f}	66.65±3.06^{h}	3.74±0.17^{h}	1.34±0.06^{f}
T_3	3.88±0.18^{jkl}	0.82±0.04^{m}	23.80±1.12^{g}	0.97±0.04^{e}	6.75±0.32^{n}	63.53±2.98^{m}	4.37±0.21^{d}	1.80±0.08^{d}
T_4	3.52±0.17^{mno}	1.26±0.06^{f}	24.06±1.18^{e}	1.58±0.07^{c}	6.96±0.34^{k}	62.52±3.06^{q}	4.78±0.23^{c}	2.50±0.12^{c}
T_5	3.22±0.14^{p}	1.31±0.05^{d}	25.00±1.13^{c}	2.00±0.09^{b}	7.66±0.35^{f}	60.67±2.73^{u}	5.20±0.31^{b}	3.10±0.14^{b}
T_6	3.26±0.13^{op}	1.71±0.07^{c}	27.40±1.12^{a}	2.56±0.11^{a}	8.90±0.37^{a}	56.64±2.32^{w}	5.90±0.41^{a}	3.59±0.16^{a}

Mean values in same column with different superscripts are statistically significant ($P\geq0.05$). T_1 (WF=100); T_2 (WF:LF:OF; 90:5:5); T_3 (WF:LF:OF; 80:10:10); T_4 (WF:LF:OF; 70:15:15); T_5 (WF:LF:OF; 60:20:20); T_6 (WF:LF:OF; 50:25:25)

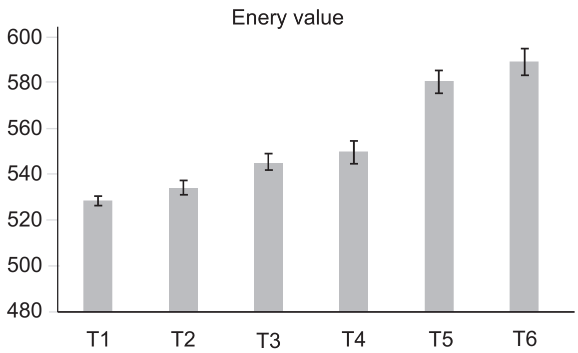

Fig. 1. Energy value (Kcal) of wheat based biscuits supplemented with lentil and oats.

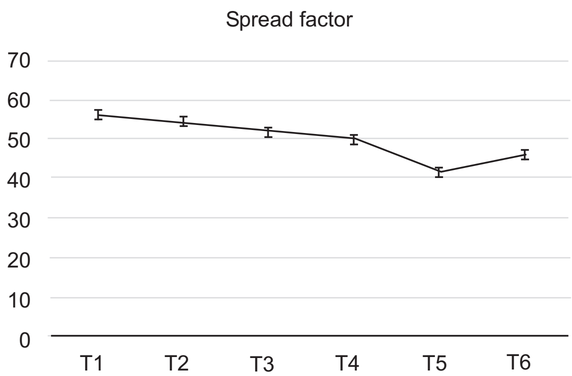

Fig. 2. Spread factor of biscuits supplemented with lentil-oat supplemented flour.

and arabinoxylan absorbed considerable quantity of water and reduced the spread of biscuit (Pauly *et al*., 2013).

Quality assessment of fresh biscuits revealed that control treatment exhibited significantly higher ($P \leq 0.05$) texture score (9.76), whereas T_6 had the lowest (5.20). It was observed that supplementation of lentil and oat flour significantly affected texture of biscuits as shown in Fig. 3. However, texture of biscuits was acceptable up to 15% incorporation of lentil and oat flour and beyond that, it was dramatically reduced leading to worst surface appearance at subsequent 20 and 25% levels. The reason for this fact can be explained as protein content increased by increasing the levels of lentil and oat flour might influence water absorption and texture of biscuits. A similar effect was mentioned by Bunde *et al.* (2010) who pointed out a decrease in texture score of biscuit by increasing the substitution of soybean flour and flours from 7.0 to 4.9. Overall acceptability of fresh

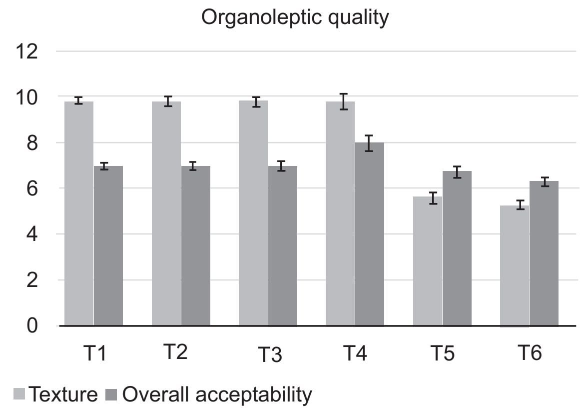

Fig. 3. Organoleptic quality of biscuits supplemented with lentil-oat supplemented flour.

biscuits supplemented with lentil-oat flour was found to be significantly highest ($P \leq 0.05$) in T_4 (7.90), however T_6 exhibited lowest value (6.20). Thus, biscuits can be successfully supplemented with lentil and oat flour at 15% level without any adverse effect on the quality.

Conclusion

In present study, the nutrient composition of lentil and oat flour was found superior as compared to wheat flour. The composite flour comprising of lentil and oat flour significantly improved the nutritional value of biscuits especially in terms of iron and zinc. The supplementation of lentil and oat flours also significantly altered the rheological attributes of wheat dough. Organoleptic evaluation of biscuits revealed their acceptance at the supplementation rate of 15%. In the current scenario, utilization of these composite flours in various food products would be a healthy choice, particularly for the consumers yearning for the high nutrition value added products. So, lentil oat supplemented biscuits could be utilized to cater the consumer requirement of improved and balanced nutrition.

Conflict of Interest. The authors declare that they have no conflict of interest.

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