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Evaluation of potato-wheat composite flour for bread production in Ethiopia

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ABSTRACT

Consumption of wheat flour for bread and other baked products has increased in Ethiopia as well as worldwide. However, the wheat produced in Ethiopia is not enough to support bakery and pastry industries. Therefore, this research aimed to evaluate suitability of composite flour from wheat and potato for commercial bread making. The experiment were conducted by blending wheat and potato flour in the ratio of 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30 respectively. The composite flour samples were evaluated for their functional propertties, rheological characteristics and proximate composition. Functional and rheological properties of wheat-potato composite flour in the ratio of 75:25 had comparable properties with 100% wheat flour. Furthermore, breads produced from this mix was evaluated for it's physical and sensory qualities. Physical and sensorial qualities of bread made from this composite flour had no significant difference from wheat flour bread at (p> 0.05). Hence, substitution of wheat flour up to 25% with potato flour is possible for commercial bread making.

1. INTRODUCTION

Wheat is the most common cereal used for making bread and different bakery products in the world (Dhingra & Jood, 2002). Consumption of wheat flour for bread and other baked products has increased in Ethiopia ase well as worldwide (Omeire & Ohambele, 2010; Edema *et al.*, 2005). Despite this importance,it only grows in abundance in a few developing countries (Sabanis & Tzia, 2009; Alvarez *et al.,* 2010). Ethiopia also does not produce wheat in a volume which fulfills the current demand of bakery and pastry industries. Hence, wheat is imported from other countries which had surplus production (CSA, 2012; USDA, 2018). Due to urbanization and fast population growth, wheat imports to Ethiopia have grown unexpectedly and imported 2,600,000 metric tons of wheat in 2015 (CSA, 2012; USDA, 2015).

Ethiopia produces large quantity of potato on 70,362.22 hectare of land and harvest of over one million metric ton (CSA, 2019/2020). Potato and other root crop postharvest loss reaches up to 50% in developing counties including Ethiopia (Mezgebe *et al.,* 2016).Processing of potato into flour is the most important technique of creating a product which is functionally adequate and can be also a means to prevent high postharvest loss of this crop in the country. Potato flour is also a known thickener and taste improver for baked products (Avula *et al*., 2006; Raj *et al*., 2008).

Ethiopia pays huge amounts of money for wheat import which is depleting the country's foreign currency and reserve. In an attempt to decrease wheat imports, the government of Ethiopia has planned to encourage partial substitution of wheat flour with other flours. Partial substitution of wheat flour with non-wheat flours may, satisfy bakery industries and purchaser demand for bread production (Trejo-González *et al.,* 2014; Mohammed *et al.,* 2012; Udensi & Eke, 2000).

Therefore, the aim of this research was to evaluate functional properties, rheological characteristics, proximate composition, baking, physical and sensorial qualities of wheat-potato composite flour for commercial bread making.

2. MATERIALS AND METHODS

2.1. Sample collection

Guasa potato (*Solanum tuberosum*) variety was collected from Adet Agriculture Research Center, Amhara Regional State, North-west Ethiopia. White wheat flour manufactured by Yage wheat flour factory PLC and other ingredients were purchased from local market in Bahir Dar city.

2.2. Preparation of potato flour

Potato was washed, peeled, sliced and blanched in boiling water for 8min and then dried using solar dryer (Hybrid model which use both solar and electrical energy) to a moisture content of 12.5%. The dried potato flakes were milled using laboratory wheat mill (Model:JMFS, Shijiazhuang mole machinery trade Col.,Ltd, China) and passed through 250µm mesh sieve size to obtain fine flour. Potato flour was packed with polyethylene plastic bags using bag-sealer (Model FS-200, Yongkang Golden Sky import and export Col.,Ltd, China). The flour samples were then stored at room temperature untill analysis.

2.3. Experimental design and treatments

The research was conducted in a completely randomized block design. During composite flour preparation, potato flour level substitution were 5%, 10%,15%,20%,25% and 30%, while the remaining part of the composite flour was wheat flour. During the study, wheat flour (100%) was taken as control. Composite flour samples were analyzed to determine functional properties, rheological characteristics and proximate composition. Composite flour with the highest proportion of potato flour and showing no significant difference in functional properties, rheological characteristics and proximate composition from the control was selected as the best composite flour for commercial bread production. Then, bread's physical characteristics and sensory quality attributes were evaluated. Proximate composition, functional properties, rheological characteristics, and physical characteristics were conducted in triplicate. Fnally, data were analyzed by Design-Expert Software Version 8.0.3.

2.4. Determination of functional properties

Bulk density

The method described by AACC (2000) was used for determination of bulk density. Flour sample (50 g) was weighed into 100 ml measuring cylinder. Measuring cylinder was then tapped continuously until constant volume was obtained.

Water absorption capacity

Water absorption capacity was determined using the method outlined by AOAC (2000) with some modifications. About 0.5 g of the sample was dissolved with 10 ml of distilled water in centrifuge tubes and vortexed for 30 second. The dispersions were allowed to stand at room temperature for 30 min, centrifuged at 3000 rpm for 25 minute. The supernatant was filtered with Whatman filter paper and the volume retrieved was accurately measured. The difference between initial volumes of distilled water added to the sample and the volume obtained after filtration was determined. Finally, results were reported as ml of water absorbed per gram of sample.

Oil absorption capacity

Oil absorption capacity was measured according to a method of AOAC (2005). About 1 g of the sample was weighed into pre-weighed 15 ml centrifuge tubes and thoroughly mixed with 10 ml (V_1) of refined pure groundnut oil using vortex mixer. Samples were allowed to stand for 30 min. The sample-oil mixture was centrifuged at 3000 rpm for 20 minute. Immediately after centrifugation, the supernatant was carefully poured into a 10 ml graduated cylinder, and then the volume was recorded (V_2). Finally oil absorption capacity was calculated and expressed as g/ml.

Emulsification capacity

The method of AOAC (1984) was adapted as described by Onwuka, (2005). Two gram (2 g) of the flour sample was blended with 25 ml of distilled water at room temperature for 30s in a warring blender at 1,600 rpm. After complete dispersion, 25ml of groundnut oil was added and blended again for another 30 second. The mixture was transferred into a centrifuge tube and centrifuged at 1,600 rpm for 5 minute. The oil and water separated, with the oil at the upper part and the water at the bottom part of the centrifuge tube. Emulsion capacity was calculated as the ratio of height of emulsion to the total height expressed as a percentage.

Swelling capacity

Swelling capacity was determined with the method described by Leach *et al.* (1959) with modification. One gram of the flour sample was mixed with 10 ml distilled water in a centrifuge tube and heated at 80ºC for 30 min. This was continually shaken during the heating period. After heating, the suspension was centrifuged at 1000 rpm for 15 min. The supernatant was decanted and the weight of the paste taken.

Least geleation capacity

Geleation capacity was determined by a method described by Mejía-Agüero *et al.* (2012), with modifications. Flours were mixed with distilled water (8% w/v) in a 15 ml centrifuge tube. The samples were then placed in a 95°C water bath for 30 min with constant shaking. After cooling to room temperature, it was centrifuged at 3000 rpm for 20 min and the supernatant was discarded. Gel formation ability was indicated by the presence of a soft gel.

PH: The pH of the samples was determined according to a method of AOAC (2000). 10 g of each sample collected and homogenized in 50 ml of distilled water. The resulting suspensions were decanted and their PH determined using PH-meter. The pH meter was standardized with buffer solutions of pH 4.0 and 7.0.

Dough rheological characteristics

Rheological characteristic of dough was determined by following methods of AACC, (2000) using farinograph (model: JFZD-300, Want balance instrument Co., Ltd, China).

Determination of proximate composition

Proximate composition (moisture, carbohydrate, fat, protein, fiber and ash content) of flour samples were determined according to a method of AOAC (2000).

Bread making process

Straight-dough bread-making method was employed in the production of bread following AACC (2000) method with little modification. Bread was developed from composite flour with blending ratio of 75% wheat and 25% potato flour. Bread was aslso developed from 100% wheat flour was control. One hundred grams (100 g) of flour, 1.8 g instant dry yeast, 6 g refined sugar, and 1.5 g salt was mixed for 1 min at speed 2 rpm. After which, 3 g of shortening was added and then it was mixed further for 3 min at the same speed. The paddle was replaced with a hook, and about 57 g of water was added. It was mixed for 1 min at speed 1rpm and for 7 min at speed 4rpm. The dough was proofed for 52 min at 25°C, punched, and then further proofed for 25 min. It was then placed in pans and proofed for another 13 min. Baking was carried out at

200°C for 24 min using baking oven (model: FER-2-4, Guangzhou astar kitchen equipment Co., Ltd, China).

Determination of physical and sensory properties

Each loaf was weighed and the volume determined using the AACC (1990) method where, pinto bean displacement was modified by using soybean. The displaced soybean was used to express the volume of the loaf. Finally, specific loaf volume (SLV) was calculated as the ratio of loaf volume to the weight.

Oven spring

Hight difference of dough before and after baking was used to determine oven spring of bread as stated by Idowu, *et al.* (1996).

Weight of bread

Weights of the loaf was determined using a method described by Feili *et al.* 2013 method. Loaf samples were placed on the weighing balance and the weight values were recorded for each sample.

Sensory analysis

Fifteen panelists consisting of 10 males and 5 females were recruited from Bahir Dar fishery and other aquatic life research center and participated. Sensory analysis was conducted based on 9-point hedonic scale where 1 disliked extremely and 9 liked extremely according to a method followed by (Iwe, 2002). Attributes tested included flavor, colour, taste, texture and overall acceptability.

3. RESULT AND DISCUSSION

3.1. Functional properties of composite flour

The effect of substituting wheat flour with potato flour on functional properties is summarized in Table 1 below. The bulk density of the composite flours ranged from 0.64 g/ml to 0.99 g/ml. Bulk density of composite flour samples had no significant difference at ($p > 0.05$) from wheat flour up to 25% potato flour substitution. Bulk density of a flour indicates its suitability for use in product development especially in bakery and pastry industries (Akapata & Akubor 1999). Different result was reported by Edema *et al.* (2005), where bulk density of composite flours increased significantly with incorporation of rice, green gram and potato flour on wheat flour.

Table 1: Functional properties of wheat-potato composite flour (P_1-P_6) (mean±standard deviation)

Properties	P_1 (95:5)	P_2 (90:10)	P_3 (85:15)	P_4 (80:20)	P_5 (75:25)	P_6 (70:30)	WF_C
SC (%)	5.12^n±1.00	6.18^n±0.13	6.52^n±1.09	6.68^n±0.63	6.78^n±0.02	3.82^l±0.24	6.01^n±0.82
WAC (ml/g)	5.82^c±0.32	6.78^c±0.87	6.57^c±0.28	6.59^c±0.35	7.68^c±0.33	4.71^d±0.23	6.21^c±0.47
pH	6.90^e±0.13	6.90^e±1.32	6.89^e±1.02	6.78^e±1.09	6.78^e±0.56	6.86^e±0.58	6.98^e±0.38
OAC (g/ml)	2.78^j±0.87	3.29^j±1.00	3.07^j±0.26	2.88^j±0.55	2.83^j±0.06	2.35^k±0.02	2.81^j±0.47
BD (g/ml)	0.89^g±0.09	0.88^g±0.08	0.99^g±0.10	0.94^g±0.06	0.83^g±0.03	0.64^h±0.02	0.80^g±0.02
EC (%)	4.82^a±0.89	4.90^a±1.20	4.98^a±0.69	5.20^a±0.18	5.89^a±0.25	3.12^b±0.24	4.83^a±0.14
LGC (%)	8.12^s±0.07	8.01^s±0.08	8.16^s±1.25	7.89^s±1.03	7.89^s±0.08	6.98^x±0.83	8.03^s±0.73

** SC= swelling capacity, WAC= water absorption capacity, OAC= oil absorption capacity, BD= bulk density,EC= emulsification capacity,LGC= least gelation concentration,*WF_C*= wheat flour control,*p_1*= composite flour with 95% wheat and 5% potato flour,* p_2*= composite flour with 90% wheat and 10% potato flour,* p_3*= composite flour with 85% wheat and 15% potato flour,* p_4*= composite flour with 80% wheat and 20% potato flour,* p_5*= composite flour with 75% wheat and 25% potato flour,* p_6*= composite flour with 70% wheat and 30% potato flour and values with different superscript in same row show significant difference (*$P < 0.05$*).*

The pH of flour samples were found from 6.78 to 6.98. High pH value for flours have been found to increase solubility due to expanded hydrophilic character of the flour at those pH values (Adeboyega, 2006). Similar result reported by Uzoukwu *et al.* (2015) as pH values of 5.48 – 6.15 for wheat- plantain flour. The pH values of composite flour samples were not significantly different ($p > 0.05$) from wheat flour (100%).

Least gelation concentration of flour samples ranged from 6.98 to 8.16%. Least gelation concentration of composite flour samples showed no significant difference ($p > 0.05$) from wheat flour when substituted with potato flour up to 25%. Similar results were reported by Kaushal *et al.* (2012) as increased incorporation of green gram, potato and rice flour on wheat flour decreased the least gelation concentration. Gelation capacity of a flours is influenced by physical competition for water between protein gelation and starch gelatinization (Kaushal *et al.,* 2012).

Water and oil absorption capacity of flour samples ranged from 4.71 to 7.78 ml/g and 2.35 to 3.29 g/ml respectively. Water and oil absorption capacity of composite flour samples had no significant difference ($p > 0.05$) from wheat flour with incorporation of potato flour up to 25%. Water absorption capacity is a vital processing parameter and a determining factor of viscosity of flours during processing. It is also vital in bulking and consistency of products, in addition to baking quality (Niba *et al.,* 2001) while oil absorption capacity enhances flavor and increases the mouth-felines of products. It also improves palatability and shelf life extension of bakery products (Aremu *et al.,* 2007).

Swelling capacity of flour samples were found as 3.82 to 6.78%. Potato flour substitution up to 25% in composite flour had no significant difference ($p>0.5$) in swelling capacity of the composite flour from 100% wheat flour. Different result was reported by Elisa-Julianti *et al.* (2017), where swelling capacity of composite flour samples became similar ($p>0.5$) irrespective of the ratio of sweet potato flour and maize starch addition on wheat flour. Swelling capacity of flours shows the degree of water absorption of the starch granules within the flour samples (Carcea and Acquistucci, 1997).

The emulsification capacity of composite flours ranged from 3.12 to 5.89%. Emulsification capacity of composite flour had no significant difference ($P > 0.05$) from 100% wheat flour with incorporation of potato flour up to 25%. On the otherhand, Uzoukwu *et al.* (2015) reported that wheat-plantain flour emulsification capacity kept constant up to 30% substitution with plantain.

Functional properties of flours are intrinsic physicochemical properties that replicate the complicated interaction between the composition, structure, confirmation and physicochemical properties of protein and other food components (Kinsella, 1976; Akubor *et al.,* 2003). Important functional properties that determine types of flour include water absorption capacity, bulk density, oil absorption capacity, pH, swelling power, emulsification capacity, least gelation concentration and swelling capacity. These parameters influence gluten formation in the flours (Oladunmoye *et al*., 2010; Shittu & Raji, 2007). Functional properties also help to decide functional use of blended flours or simply use of composite flour for various products such as bread, pastry and biscuits (Udensi, 2000; Alobo, 2003).

3.2. Rheological characteristics of composite flour

Water absorption capacity, dough development time and dough stability time of the flours presented in Table 2 below. Water absorpition capacity of the composite flour was found 521.12 to 680.09 ml/100g. Water absorption capacity of composite flours had no significant difference ($p > 0.05$) from the wheat flour up to 25% substitution of potato flour. Similar result was reported by Mansour *et al.* (1999), in addition of pumpkin to wheat flour. Increasing trends in water absorption capacity with increase in taro flour proportion had been also reported by (Njintang *et al*., 2008). However, an increase in taro flour proportion in wheat-taro composite flour has been reported to decrease water absorption capacity (Ikpeme-Emmanuel *et al.,* 2010).

The dough stability time and dough development time of composite flour ranged from 8.03 to 18.26 minute and 3.08 to 10.32 minute respectively. Similar dough development and stability time was reported for fruit-wheat composite flour by Adegoke *et al.* (2016). Ndayishimiye *et al.* (2016) and Kaur *et al.* (2016) also reported that, dough development time and dough stability time decreased with increasing of potato flour on wheat flour. Similar reduction of dough stability with increased substitution of non-wheat flour was reported (Chauhan *et al.,* 1992; Okaka & Potter, 1977). Composite flour which had similar rheological properties with wheat flour had the potential to substitute wheat in bread production (Torbica *et al.,* 2010).

Table 2: Rheological properties of composite flours (Mean± SD)

Properties	P_1(95:5)	P_2(90:10)	P_3(85:15)	P_4(80:20)	P_5(75:25)	P_6(70:30)	Wheat
DDT (min)	$8.68^{a}\pm0.2$	$8.16^{a}\pm0.1$	$8.12^{a}\pm0.9$	$8.89^{a}\pm0.3$	$10.32^{a}\pm1.3$	$3.08^{b}\pm 0.9$	$8.39^{a}\pm0.1$
WAC (ml/100g)	$632.65^{l}\pm1.5$	$680.09^{l}\pm1.3$	$630.34^{l}\pm2.1$	$634.08^{l}\pm1.8$	$660.98^{l}\pm2.0$	$521.12^{k}\pm2.3$	$662.10^{l}\pm1.3$
DST (min)	$18.26^{e}\pm0.98$	$16.08^{e}\pm1.0$	$14.28^{e}\pm1.0$	$12.16^{e}\pm0.8$	$13.08^{e}\pm0.1$	$8.03^{g}\pm0.03$	$16.12^{e}\pm1.0$

** p_1= composite flour with 95% wheat and 5% potato flour, p_2= composite flour with 90% wheat and 10% potato flour, p_3= composite flour with 85% wheat and 15% potato flour, p_4= composite flour with 80% wheat and 20% potato flour, p_5= composite flour with 75% wheat and 25% potato flour, p_6= composite flour with 70% wheat and 30% potato flour, DDT=dough development time, DST= dough stability time, WAC=water absorption capacity, WF_C=wheat flour control, and values with different superscript in same row show significant difference ($P < 0.05$).*

Proximate composition of composite flour

The proximate composition of composite flours shown in Table 3. The moisture content was found to be in the range of 10.68 to 11.51%. Moisture content of composite flours had no significant difference ($p > 0.05$) from wheat flour up to the final potato flour substitution. But, different result was also reported by Adebowale *et al.*, (2008) on moisture content of the composite flour as yam flour increased on sweet potato-wheat flour.

Table 3: Proximate composition of wheat-potato composite flours (Mean±SD)

Content (%)	P_1 (95:5)	P_2 (90:10)	P_3 (85:15)	P_4 (80:20)	P_5 (75:25)	P_6 (70:30)	WF_C
Moisture	$10.81^a \pm 0.24$	$10.68^a \pm 1.20$	$10.83^a \pm 0.25$	$10.98^a \pm 1.09$	$10.72^a \pm 0.08$	$10.78^a \pm 0.34$	$11.51^a \pm 0.08$
Crude fat	$1.21^b \pm 0.13$	$1.12^b \pm 0.23$	$1.02^b \pm 0.18$	$1.82^c \pm 0.15$	$2.03^c \pm 0.14$	$2.34^c \pm 0.34$	$1.36^b \pm 0.43$
Crude protein	$7.11^d \pm 0.19$	$6.82^d \pm 0.32$	$6.49^d \pm 0.17$	$6.28^d \pm 0.19$	$5.74^d \pm 0.25$	$4.97^e \pm 0.36$	$7.97^d \pm 0.17$
Carbohydrate	$79.67^f \pm 0.17$	$79.32^f \pm 1.00$	$80.43^f \pm 0.23$	$79.99^f \pm 1.20$	$80.03^f \pm 0.01$	$81.12^f \pm 0.29$	$79.21^f \pm 0.28$
Crude fiber	$2.68^g \pm 0.13$	$2.67^g \pm 0.12$	$2.97^g \pm 0.17$	$3.01^g \pm 0.19$	$3.21^h \pm 0.16$	$3.35^h \pm 0.89$	$2.47^g \pm 0.47$
Ash	$2.01^j \pm 0.76$	$2.21^j \pm 0.08$	$2.32^j \pm 0.07$	$2.46^j \pm 0.10$	$2.61^j \pm 0.12$	$1.76^j \pm 0.09$	$1.68^j \pm 0.02$

**p_1= composite flour with 95% wheat and 5% potato flour, p_2= composite flour with 90% wheat and 10% potato flour, p_3= composite flour with 85% wheat and 15% potato flour, p_4= composite flour with 80% wheat and 20% potato flour, p_5= composite flour with 75% wheat and 25% potato flour and p_6= composite flour with 70% wheat and 30% potato flour.Values with different superscript in same row show significant difference ($P < 0.05$).*

Crude fat content of the composite flour ranged 1.02 to 2.34%. Fat content of composite flours had no significant difference ($p>0.05$) from wheat flour up to 15% potato flour substitution.Carbohydrate content of flour samples ranged from 79.21% to 81.12%. Carbohydrate content of composite flours had no significant difference ($p > 0.05$) from that of wheat flour. The ash and crude protein content of composite flours ranged from 1.68 to 2.61% and 4.97 to 7.97% respectively. Composite flour crude protein content had no significant difference ($p > 0.05$) from wheat flour up to 25% potato flour substitution while the ash content remain similar up to the final potato flour substitution. Crude protein content of composite flours had significant difference from wheat flour with addition of potato flour greater than 25%. Crude fiber content of the composite flours ranged 2.47% to 3.35%.There was no significant difference ($p > 0.05$) in crude fiber content of composite four and wheat flour for potato flour substitution up to 20%. Crude fiber of composite flour had significant difference from wheat flour containing potato flour greater than 20%. Similar finding was reported by Dhingra & Jood, (2002) when soya and barely fours were added to wheat flour. The protein content found in the composite flour was similar with wheat flour. The ash content of flours indicates the amount of inorganic content which directly shows mineral content of the samples. The values obtained for ash contents showed the composite flour could provide essential minerals needed for body metabolism. Crude fiber contributes to the health of the gastrointestinal and the metabolic system (Beghin *et al.,* 2022).

3.3. Physical quality of composite flour bread

Physical quality characteristics of the composite flour bread and wheat bread shown in Table 4. Bread was prepared from composite flour (P_5) 75% wheat flour and 25% potato flour. Loaf volume, loaf weight, specific loaf volume and oven spring of bread samples ranged 350.14 to 360.14 cm^3, 149.08 to 150.30 gm, 2.33 to 2.416 cm^3/g and 2.03 to 2.08 cm respectively. The loaf volume, loaf weight, specific loaf volume and oven spring of the bread from selected composite flour (75:25) had no significant difference ($p> 0.05$) from the wheat flour bread. This result approved that incorporation of potato flour up to 25% will not affect bread physical quality attributes. Loaf weight is essentially determined by the amount of dough baked and the quantity of moisture and carbon dioxide subtle out of the loaf during baking (Ragae & Abdel-Aal, 2006). Loaf weight also indicates the water preserving capacity of the flour, which increases productivity of the bread (Edema *et al.,* 2005). Loaf volume is limited by the amount and quality of protein in the flour. Similar result was reported by Amandikwa *et al.* (2015) on loaf volume where loaf volume had no significant difference ($P> 0.05$) when wheat flour was substituted by Yam flour up to 25%. Different result also reported by Liu Xing *et al.* (2016) where specific loaf volume decrease from 2.95 to 1.24 ml/g by substitution of potato flour from 10 to 35% in wheat flour.

Table 4: Bread physical quality parameters (Mean±SD)

Bread samples	SLV (cm^3/g)	LW (gm)	LV (cm^3)	OVS (cm)
P_5B (75:25)	$2.416^b \pm 1.01$	$149.08^a \pm 0.03$	$360.14^a \pm 1.11$	$2.08^a \pm 0.01$
WF_B	$2.330^b \pm 0.98$	$150.30^a \pm 0.04$	$350.14^a \pm 1.31$	$2.03^a \pm 0.03$

** SLV=specific loaf volume, LW = loaf weight, LV=loaf volume, OVS=oven sprig, P_5B= Bread from composite flour (75:25) blends of wheat and potato flour respectively, WF_B= wheat flour bread (100%) and values with different superscript in same column show significant difference ($P < 0.05$).*

Amandikwa *et al.* (2015) reported the specific loaf volume and loaf volume had significant difference from the wheat flour by substitution of wheat flour with Yam flour at 25%. Gaimi (2003) and Misra *et al.* (1991) reported significant difference of loaf volume and loaf weight of bread when wheat flour is supplemented with germinated and un-germinated pumpkin seed and soybean flours respectively. Bakare *et al.* (2016) and Malomo *et al.* (2013) stating contradicting result with this research finding where the loaf volume and specific loaf volume decreased with substitution of wheat flour by potato flour. Higher loaf weight of composite bread samples showed retention of carbon dioxide within the dough (Rao & Hemamalini, 1991).

Sensory quality attributes

The texture, color, flavor, taste and overall acceptability of composite flour of 25 % potato flour and 75% wheat flour and 100% wheat flour bread shown in Table 5. Texture, colour and overall acceptability of breads from composite flour were found no significant difference (p > 0.05) from wheat flour bread. Taste and flavor of composite flour bread significantly higher than wheat flour. The taste and flavor enhancement of composite flour bread may rise from potato carbohyderate and starch nature.

Table 5: Sensorial characteristics of wheat- potato composite bread (Mean± SD)

Bread samples	Texture	Taste	Flavor	Color	Overall acceptability
P_5B	$7.34^a \pm 0.10$	$8.38^a \pm 0.09$	$8.20^a \pm 0.02$	$8.12^a \pm 0.03$	$8.68^a \pm 0.13$
WF_B	$7.61^a \pm 0.12$	$6.87^b \pm 0.31$	$7.39^b \pm 0.03$	$8.02^a \pm 0.04$	$8.80^a \pm 0.10$

** P_5B= Bread from composite flour (75:25) blends of wheat and potato flour respectively, WF_B= wheat flour bread (100%).Values with different superscript in same column show significant difference ($P < 0.05$).*

Sensory quality parameter results showed that bread prepared from composite flour by addition of 25% potato flour had no significant difference (p> 0.05) from 100% wheat flour. This proves, potato flour can substitute wheat flour up to 25% for commercial quality bread production. Amandikwa *et al.* (2015) reported similar finding as the texture, flavor, taste, color and overall acceptability of bread samples were found no significant difference (p>0.05) from wheat bread with incorporation of 25% Yam flour. Quality bread was produced from Chinese yam (*D. esculenta*) flour at 30% wheat flour substitution as reported by Ukpabia & Uchechukwu (2001).

4. CONCLUSION AND RECOMMENDATION

Potato flour incorporation increased carbohydrate and fiber content of the composite flours. The functional properties, such as water absorption capacity, oil absorption capacity, pH, bulk density, emulsification capacity, sweeling capacity and least gelation capacity were found similar to 100% wheat flour with substitution of potato flour up to 25%. Composite flour could be prepared with addition of potato flour up to 25% on wheat flour without change of dough development and dough stability time. The research work also approved that physical and sensory properties of bread developed from composite flour of 25% potato and 75% wheat folur and wheat flour had no significant difference. Therefore, it could be concluded that it is possible to produce commercial bread having improved nutritional, comparable bread physical and sensory quality attributes with potato flour substitution of wheat flour up to 25%. Hence, utilization of wheat-potato composite flour for commercial bread production in Ethiopia on an industrial scale should be promoted.

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