International Journal of Food Engineering and Technology
2023; 7(2): 79-87
http://www.sciencepublishinggroup.com/j/ijfet
doi: 10.11648/j.ijfet.20230702.12
ISSN: 2640-1576 (Print); ISSN: 2640-1584 (Online)

Characterization of Physicochemical, Functional, and Pasting Properties of Made from Wheat, Grass Pea, Anchote, and Blends Flours

Bekele Kuma[1, *], Habtamu Admasu[2, 3], Shire Leta[1]

[1]Department of Chemical Engineering, Bule Hora University, Bule Hora, Ethiopia

[2]Department of Food Process Engineering, Addis Ababa Science and Technology University, Addis Ababa, Ethiopia

[3]Biotechnology and Bioprocessing Center of Excellence, Addis Ababa Science and Technology University, Addis Ababa, Ethiopia

Email address:

bekelekuma98@gmail.com (Bekele Kuma), habtamu.admasu@aastu.edu.et (Habtamu Admasu), shireleta99@gmail.com (Shire Leta)

[*]Corresponding author

To cite this article:

Bekele Kuma, Habtamu Admasu, Shire Leta. Characterization of Physicochemical, Functional, and Pasting Properties of Made from Wheat, Grass Pea, Anchote, and Blends Flours. *International Journal of Food Engineering and Technology*. Vol. 7, No. 2, 2023, pp. 79-87. doi: 10.11648/j.ijfet.20230702.12

Received: August 23, 2023; **Accepted**: September 11, 2023; **Published**: October 8, 2023

Abstract: This study investigated the use of composite flour from wheat-anchote-grass pea flour for bread products. Composite flours were prepared from the blends of wheat-anchote and grass pea in different proportions (A) 100% control, 90:5:5% (B), 80:10:10% (C), 70:15:15% (D), 60:20:20% (E), and50:25:25% (F). The proximate composition of blended flours was moisture content (10.13-10.32%), carbohydrate (63.8-69.32%), ash (2.23-2.71%), crude fat (1.54-1.68%), crude protein (15.37-19.91%) and crude fibre (1.22-2.47%). The crude protein content of the flours was recorded wheat flour 12.34%, anchote 1.15%, grass pea 28.68%. Similarly, bulk density, water absorption capacity (WAC), and oil absorption capacity (OAC), showed significant ($P < 0.05$) increases as the blend ratio of wheat flour in the blends decreased, while bulk density and dispersibility flour decreased. The values for WAC, OAC, dispersibility flour and bulk density were 59.28–67.2%, 1.36-2.18 ml/g, 74-69.3% and 0.64-0.79g/ml, respectively. The color analysis showed L*, a*, b*, WI and chroma values of the wheat, anchote and grass pea flours were L* (89.6,88.89,76.51), a* (0.42,0.82,2.65), b* (9.17,15.29,11.56) WI (86.92,85.37,77.49) and, chroma (9.17,10.32,11.86), respectively. There was a significant ($P<0.05$) difference among the flours. Peak viscosity (759-1529 cP), holding strength (1366-335 cP) and final viscosity (103-604 cP), setback (237.11-269cP) and pasting temperature (54.96-65.65°C) were highest at 50% anchote-grass pea flour substitution. The peak, setback, and final viscosities increased as composite flour increased, whereas pasting temperature and time increased as the anchote-grass pea flour ratio increased.

Keywords: Composition, Functional Properties, Grass Pea, Anchote

1. Introduction

The improvement of wheat flour with legume flours, roots and tubers flours is an attractive to improve the nutritional quality of cereal-based foods is well known that the legumes' amino acidic composition is balancing to the one of cereals [1] and they are also rich in bioactive compounds such as fibres and phytochemicals [2, 3]. Gluten is not existing in roots and tubers flours [2]. However, Anchote flour has some an essential property such as good adhesive strength, high water binding capacity and a low tendency for starch retrogradation, and good stability. This study focused on legumes and roots crops grown in Ethiopia, i.e., Grass pea and Anchote, which were chosen for their high nutritional contents.

Grass pea are a legume crops widely harvested around the globe. Grass pea crops are largely cultivated due to resistance to drought, waterlogging, salinity, and low soil fertility [4]. Grass pea use serve animal feed and fodder, but also as human food. Grass pea (lathyrus sativus) belongs Fabaceae (Leguminosae) family [5]. It is widely used for human consumption around drought areas [6, 7]. It is rich source of protein, carbohydrate, dietary fibre, vitamins, minerals [8-10]. However, it still remains undervalued and underutilized [7], due to β-ODAP is the toxic amino acid existing in Grass pea [11]. Therefore, pre-treatment Grass pea seeds in water, alkaline, salt, rock salt, and wood ash solutions and roasting, leaching in water potentially decreased β-ODAP content and other anti-nutritional factors [7, 11, 12]. Grass pea flour has not been utilized to its full potential as an ingredient in bakery products, although it is used as pea flour (Shiro), Porridge with or without mixing with other legumes flours for the traditional food preparation of Ethiopia and cooked as snack food (roasted mixed with salt), Nefro, kollo, and local beverage known as "Arake [7].

Anchote tubers is among the most important tuber crops in western part of Ethiopia [13-16]. It is the primary source of macro minerals and rich source of carbohydrate, fat, dietary fibre, minerals, vitamins, and anti-nutritional (Meybodi et al., 2019). Therefore, it is application in traditional of food, such as in soups, and porridge [17-21]. In addition, anchote is the preferred calcium source for infants and children to support normal growth, strengthening their bones, and teeth [17].

Composite flour refers to the mixture of different concentrations of non-wheat flours from cereals, legumes, dairy, roots and tubers with wheat flour or can be a mixture of flours other than wheat flour [22]. Therefore, use of composite flours, lowering prices and providing nutritionally superior processed foods [23, 24]. Study importance characterization the physicochemical, functional property, rheological, pasting property of flours.

2. Materials and Method

Anchote (Coccinia abyssinica (Lam.) Cogn.) and grass pea seeds (wassie variety) used for this study were collected from the Debre Zeit Agricultural Research Center (DZARC), which is located 47 km southeast of Addis Ababa, Ethiopia, stored in plastic bags, and transported to the laboratory immediately without any delay. The samples harvested in 2021GC selected for this study. Wheat flour was obtained from the Universal Food Complex, Akaki kality, Addis Ababa.

2.1. Sample Preparation

2.1.1. Grass Pea Seed Soaking as a Pre-Treatments of Grass Pea

The Grass pea seeds were used winnowed and manually sorted in order to remove all foreign grains, defective seeds, stones, straws, dust materials, immature grains, and other seeds. The cleaned seeds were soaked in distilled water (1:5w/v) and the soaked water changed four times for 9 hrs at room temperature. At the end of the soaking time, the soaked water was discarded. The seeds were roasted uniformly in an oven placed in a rotating container at 150°C for 30 min. The roasted seeds were split into two parts.

The it's were separated the hulling and grinding as the form of grass pea flours produced the fine flours by using a pin grinder (Fritsch Roller, German) [25]. Grinding samples passed through a 150 µm sieve to obtain a fine, homogenized flour. Finally, these flour samples were wrapped in bags and stored at room temperature until further analysis.

2.1.2. Pretreatment and Preparation of Anchote Flour

Anchote flour was prepared according to [19]. Anchote tubers were rinsed in running tap water to remove sand, dirt, and foreign materials. The tubers were peeled and sliced with a knife to uniform 5mm thickness [26] and then blanched at 100°C for 5 min in water containing sodium metabisulphite [27] so as to prevent the browning reaction. Then anchote tubers were placed on a sieve to remove water, and blanched chips were spread on a stainless-steel tray, then dried in an oven at 40°C for 24 hrs until a low moisture level, less than 12%. The dried tuber chips were grounded into flour by a laboratory mill and then the flour was sieved through a 150 µm mesh screen. After that, the anchote flour was wrapped in a plastic bag and kept at room temperature until the analysis.

2.2. Formulation of Flour Blends

The blended mixture of wheat, anchote, and grass pea flours was proportionally blended according to the [28]. About six blends ratio, including control flour, were prepared by mixing the wheat flour with grass pea and anchote flours in the proportions of 100% (w/w) wheat flour (A) as a control, 90:5:5% (B), 80:10:10% (C), 70:15:15% (D), 60:20:20% (E), 50:25:25% (F) as shown in Table 1. Finally, flour samples were wrapped in bags and maintained at room temperature until use for analysis and bread production.

Table 1. *Blending ratios of flours composite in bread formulation.*

Sample code	Wheat flour (%)	Grass pea flour (%)	Anchote flour (%)
A	100	0	0
B	90	5	5
C	80	10	10
D	70	15	15
E	60	20	20
F	50	25	25

(A) WF-100% wheat flour; B-90% wheat flour + 5% anchote +5% grass pea flour; C-80% wheat flour + 10% anchote flour+10% grass pea flour; D-70% wheat flour + 15% anchote+ 15% grass pea flour; E-60% wheat flour + 20% anchote flour +20% grass pea flour; F-50% wheat flour + 25 % anchote+25% grass pea flour

2.3. Proximate Grass Pea, Anchote, Wheat and Composite Flours

Moisture, crude protein, ash, crude fat, and crude fiber content were determined according to the method of [29].

2.4. Functional Properties Grass Pea, Anchote, Wheat and Composition Flours

2.4.1. Bulk Density

The bulk density of the flour samples was measured by filling measuring cylinder of 200 mL with 40 g of flour. The volume employed by the flours was read after light tapping and the bulk density was calculated as g/ml using the method suggested by [30].

$$\text{Bulk density(g/ml)}=\frac{\text{Weight flour}}{\text{Flour Volume}}\text{(g/ml)}$$

2.4.2. Water Absorption Capacity

Water absorption capacity was determined according to procedure of [31]. One gram of the flour samples (W_1) was mixed with 10 ml of distilled water in the pre-weighed graduated centrifuge tube (Pro-Analytical C 2004, UK) and weighed as (W_2). The mixtures were vigorously vortexed and stirred to disperse the samples uniformly in distilled water. Then, the solution was expected to remain for 25 minutes at room temperature before being centrifuged for 25 minutes at 3500 rpm. The pure supernatant was poured and discarded, and the graduated centrifuge tubes were weighed as (W_3). The test was performed in triplicate for each type of flour. The percentage of WAC (%) of the flour was calculated according to the following equation:

$$WAC\ (\%)=\frac{(W_3-W_2)}{W_1}\times 100$$

2.4.3. Oil Absorption Capacity

The oil absorption capacity was measured according to the method of [32]. One gram of the sample flours was weighed into pre-weighed 15 ml centrifuge tubes (Pro-Analytical C 2004, UK) and thoroughly mixed with 10 ml (V_1) of refined sunflower oil using a vortex mixer. Samples were continued to stand for 30 min. The samples-oil mixture was centrifuged at 3000 rpm for 25 min. Immediately after centrifugation, the supernatant was carefully poured into 10 ml graduated cylinder, and the volume was determined (V_2). OAC of the absorbed oil was calculated according to the following equation:

$$OAC(ml/g)=\frac{(V_1-V_2)}{W}$$

2.4.4. Dispersibility

About ten grams of each flour sample was weighed into a (100 mL) measuring cylinder. Distilled water was added to reach the volume of 100mL. The arrangement was stirred vigorously and allowed to stand for 3 hours. The volume of settled particles was measured and calculated the difference from 100. This was determined by the method described by [33]. The dispersibility was calculated according to the following equation.

$$Dispersibilty\ \% = 100 - volume\ of\ setted\ particle$$

2.5. Color of Grass Pea, Anchote, Wheat and Composite Flours

The color of flours determination such as L*(lightness/darkness), a*(redness/green), and b* (yellowness/blueness) and Whiteness index (WI) were measured after being standardized and 'L*' (0 to100), a* specified redness (+) to greenness (-) axis and b* specified yellowness (+) to blueness (-) axis. Calibration was accomplished before each investigation with black, white and standard tiles [34].

$$C^*=\sqrt{(a^*)^2+(b^*)^2}$$

$$WI=100-\sqrt{(100-L^*)^2+a^{*2}+b^{*2}}$$

2.6. Rapid Visco Analyzed Method

The pasting profile of the flour sample was determined using Rapid Visco Analyser (model no 4500 Perten instrument Ltd, Sweden, 2015) according to [35] was used to determine the pasting parameters of composite and individual flours upon heating and cooling. Distilled water (25 mL) was added to 3.5 g of the sample placed into the RVA canister. A paddle was inserted and shake through the sample before the canister was inter the RVA. The temperature was first maintained at 50°C for 1min to obtain a uniform temperature and then raised to 95°C at a rate of 12°C/min with continuous stirring at 160 rpm, held at 95°C for 2.5 min, cooled to 50°C at a rate of 12°C/min, and finally held at 50°C for 2 min. All pasting parameters were measured including: Peak viscosity (PV), breakdown viscosity (BV=PV-TV), trough viscosity (TV), final viscosity (FV), set back value (SBV=FV-TV), and pasting temperature (P_T).

2.7. Data Analysis

The data was subjected to one way analysis of variance using SPSS statistical software version 21.0, and significance was accepted ($p < .05$).

3. Results and Discussions

3.1. Proximate Composition of the Grass Pea, Anchote, Wheat and Bends Flours

The chemical composition of the wheat flour, anchote flour (AF), grass pea flour (GPF) and their blends are shown in Table 1. The moisture, ash, protein, fat, fibre, and carbohydrate contents ranged from 8.75 to 11%, 1.3 to 2.71 %, 1.15% to 19.91, 1.29 to 1.68 %, 1.2 to 2.47%, and 63.83 to 89.62%. The moisture content in composite flour was ranged from 10.13±0.16% to 10.32±0.62%. The highest moisture content was obtained for B (10.32±0.62 %) and the lowest for F (10.13± 0.16%) in the composite flours. There were significant differences ($p<0.05$) in the moisture content of the wheat, grass pea and anchote flours, except for all composite flour (B-F), there were no significant differences. This result showed that the moisture content of composite flours slightly decreased with an increase in the proportions of anchote-grass pea flours. The moisture content of composite flours was slightly affected by the addition of grass pea and anchote flours to wheat. It was concluded that the value of the obtained moisture content in the composite flour was lower than the recommended moisture level (14%) for safe storage.

Table 1. *Proximate composition of individual and composite flours.*

Flours	Moisture%	Ash%	Protein%	Fat%	Fiber%	CHO%
(A) WF	11±0.35^{a}	1.3±0.07^{h}	12.34±.053^{f}	1.29±0.64^{f}	1.2±0.05^{g}	75.125±0.8^{b}
AF	9.56±0.35^{c}	4.98±0.19^{a}	1.15±0.03^{g}	1.76±0.02^{a}	2.65±0.16^{a}	82.55±0.01^{a}
GPF	8.75±0.12^{d}	2.94±0.11^{b}	28.68±0.19^{a}	1.47±0.01^{e}	2.07±0.141^{c}	58.9±0.79^{g}
B	10.32±0.62^{b}	2.23±0.10^{g}	15.37±04^{e}	1.54±0.13^{d}	1.22±0.12^{f}	69.32±0.64^{c}
C	10.26±0.60^{b}	2.38±0.01^{f}	16.97±02^{d}	1.57±0.02^{cd}	1.35±0.07^{e}	67.47±0.01^{d}
D	10.24±0.49^{b}	2.5±0.06^{e}	17.96±001^{cd}	1.59±0.13^{c}	1.68±0.13^{d}	66.04±0.01^{e}
E	10.22±0.63^{b}	2.64±0.13^{d}	18.95±0.01^{c}	1.64±0.01^{b}	2.04±0.12^{c}	64.53±0.08^{e}
F	10.13±0.16^{b}	2.71±0.08^{c}	19.91±0.14^{b}	1.68±0.01^{b}	2.47±0.13^{b}	63.83±0.35^{f}

Values are means ± SD and values in the same column with different superscript letters are significantly different from each other (n=3, P<0.05). WF=100% wheat flour AF=100%anchote flour, GPF=100% grass pea flour= 90% wheat flour+5% Anchote flour+5%grass pea flour, C=80%wheat flour+10%anchote flour+10% grass pea flour, D=70% wheat flour+ 15% anchote flour+ 15% grass pea flour, E=60% wheat flour+20% anchote flour+20% grass pea flour, F=50%wheat flour+25% anchote flour +25%grass pea flour.

Ash content ranged from 2.23±0.1 to 2.7±0.08% of composite flours. As shown in Table 1, Anchote, grass pea into wheat flour blend ratios had the highest ash content of 2.71 ±0.08 % for the (F) sample and the lowest ash content of 2.23 ±0.01% for the (B) sample. There was a significant difference (p <0.05) of the composite flours. The ash content of the flours was similar to that reported by [36] for mixing wheat with soybean. As the proportion of anchote, grass pea flour increases, so increases the ash content of blend ratio. The minerals of flours an important in daily intake for human health and nutrition.

The crude protein content of wheat, grass pea, and anchote flours was obtained 12.34±0.53%, 28.68±0.04%, and 1.15±0.03%, respectively, as shown in Table 1. There were significant (p<0.05) differences in flours. The grass pea flour had the highest amount of protein (28.68±0.19%), followed by the composite flour F (19.91±0.14%), and the lowest protein content was obtained (15.37±0.04% for (B) sample. The control wheat sample obtained protein a value of 12.34±1.34%, while the composite (F) had the highest value of 19.91±0.14%. This increase in protein content served to complement the amino acid profile of wheat, which is limited in lysine [37]. The crude fat content obtained in this study was 1.76±0.02 % in Anchote, 1.29±0.64 % in control wheat, and 1.47±0.01% in grass pea flour. The crude fat content of the composite flour from samples B to F ranged from 1.54±0.13% to 1.68± 01%), with control wheat flour (A) comprising the least value of 1.54± 0.13% while sample (E) recorded the highest value of 1.68±0.01%. There were significant differences (p<0.05) in the fat content of the flour blends except for blends E and F. The results of the crude fat content were similar to the range of 1.27 to 1.8% reported by [38] in the composite of wheat, cassava, and cowpea flours. Therefore, flours with high crude fat content are also good as flavor enhancers and useful in improving the palatability of food.

Anchote flour had the highest crude fiber content (2.65±0.05%), whereas in control wheat flour (1.2±0.05%) the lowest crude fiber content. These findings were consistent with those obtained by [39]), who studied vetch flour. The crude fibre content of the composite flour ranged from 1.22±0.12 % to 2.47±0.10 %. The results obtained showed that sample (F) had the highest crude fiber (2.46± 0.28%) and flour (B) (1.22±0.35%) the lowest crude fiber content. There was a significant difference (p<0.05) between among wheat, grass pea, anchote and composite flours. The crude fibre in composite flours increased as the anchote-grass pea flour addition increased. This reveals that grass pea and anchote flour may be combined to boost the fibre content of bread products.

The carbohydrate content of anchote flour was 82.87±0.01%, control wheat flour was 75.12± 0.88% and grass pea flour was 58.9±079 % present in Table 1. Anchote flour had the greatest carbohydrate content. The total carbohydrate content of composite flours ranged from 69.32±0.64 to 63.83±0.35%. The carbohydrate content of the composite flours decreases as the anchote, grass pea flour concentration increased. Sample B had the greatest carbohydrate content (69.32±0.64%), whereas sample F had the lowest (63.83±0.35%). However, when compared to wheat, anchote, and mixed flours, grass pea flour had the lowest carbohydrate level shown in Table 1. This is due to anchote and wheat flour being rich in carbohydrates, whereas grass pea flour was lower in carbohydrates relative to anchote and control wheat flour. There were significant differences (p < 0.05) among flours except for samples (D) and (E), which were not significantly different.

3.2. Functional Property Grass Pea, Anchote, Wheat Fours and Blends Flours

The bulk density of wheat, grass pea, anchote flours and composite flours are described in Table 2. The bulk density was 0.81±0.14g/mL in anchote, 0.75±0.03g/mL control wheat, and 0.68±0.01g/ml grass pea flour. The bulk density of the composite flour ranged from 0.79 to 0.64g/ml. The anchote flour had the highest bulk density and the lowest for the sample (F). This result is similar to the finding of [40], who reported that blending non-wheat into wheat decreased the bulk density of flour. There were significant differences (p<0.05) among flours except for grass pea flour and sample E, which were not significantly difference. Bulk density is important in food packaging requirements, food material handling, and application in processing in the food industry.

Table 2. *Functional Properties of wheat, anchote, grass pea, and composite flours.*

Treatment	BD (g/ml)	WAC (%)	OAC (ml/g)	DS (%)
(A) WF	0.75±0.03[c]	57.81±0.57[g]	1.81±0.22[c]	76.50±0.5[a]
AF	0.81±0.14[a]	73.75±0.06[b]	1.96±0.04[b]	75.50±0.25[a]
GPF	0.68±0.01[e]	85.90±0.14[a]	1.51±0.31[g]	66.00±0.41[d]
B	0.79±0.01[b]	59.28±0.01[f]	1.36±0.01[f]	74.00±0.13[a]
C	0.76±0.52[d]	59.85±0.35[ef]	1.44±0.02[ef]	73.00±0.43[ab]
D	0.73±0.4[cd]	62.18±0.24[e]	1.53±0.03[e]	72.30±0.42[abc]
E	0.69±0.21[e]	64.35±0.54[d]	1.66±0.13[d]	70.30±0.42[bc]
F	0.64±0.01[f]	67.20±0.23[c]	2.18±.04[a]	69.30±0.41[cd]

Values are means ± SD and values in the same column with different superscript letters are significantly different from each other (n=3, P < 0.05). WAC (water absorption capacity), DS (dispersibility), OAC (Oil absorption capacity) WF=100% wheat flour AF=100%anchote flour, GPF=100% grass pea flour, B= 90% wheat flour+5%Anchote flour+5%grass pea flour, C= 80%wheat flour+10%anchote flour+10% grass pea flour, D=70% wheat flour+ 15% anchote flour+ 15% grass pea flour, E=60% wheat flour+20% anchote flour+20% grass pea flour F=50%wheat flour+25% anchote flour +25% grass pea flour

As shown in Table 2, grass pea flour (85.905±0.14%) had the highest water absorption capacity (WAC) followed by anchote (73.75±0.06 %) and while the control wheat flour had the lowest (57.81± 06%). The water absorption capacity of composite flour ranged between 59.28±0.01 to 67.20±0.23%. There were significant differences (p<0.05) among them. The result of composite flour was similar to lupin and soy flour blends to wheat flour by [41]. Water absorption capacity plays an important role in bakery products such as bread, cookies, and cakes, that require hydration.

The oil absorption of wheat, anchote, grass pea, and composite flours were significant difference (p<0.05) among flours. Anchote flour had the highest amount of OAC (1.96±0.04ml/g) content when compared with wheat (1.81±0.22ml/g), and grass pea (1.51±0.31ml/g) flour. The OAC of composite flours ranged from (1.36±0.01 to 2.18±0.04 ml/g). The composite flour (F) had the highest OAC (2.18±0.04ml/g) and the lowest for B (1.36±0.01ml/g) as compared to wheat flour (1.81±0.22ml/g). This result showed that the OAC of composite flours increased with an increase in the proportion of anchote-grass pea flours. The OAC of wheat flour was in close agreement with the report by [35], which was in a range of cassava with wheat blends 1.27 to 1.82 ml/g). This is an indication that the blends would be useful in the structural interaction in food, especially in flavor retention and palatability of bakery products [42, 43]. Wheat flour had the highest amount of dispersibility content (76.5±0.5%) when compared with anchote (75.50±0.25) and grass pea (66±0.41%) flours were obtained. The result obtained for dispersibility composite flours ranged between 74-69.36%. Therefore, it is clear that the dispersibility of composite flours decreased with an increase in the ratio of grass pea, anchote to wheat flours. There were significant differences (p<0.05) among the flour samples, except for wheat flour (A), grass pea flour, and sample (B), which were not significantly different. Flour dispersibility an indication of particle suspensibility in water, which is the beneficial parameter in various food product formulations. Dispersibility is reflects the rate at which a flour sample is reconstituted in water [44].

3.3. Color Determination

The color values, L* (lightness), a* (+red/-green), and b* (+yellow/-blue), whiteness, and chroma of the individuals and composite are shown in Table 3. The color analysis showed; L*, a*, b*, WI and chroma values of the wheat, anchote and grass pea flours were L*(89.6,88.89,76.51), a*(0.42,0.82,2.65), b*(9.17,15.29,11.56) WI (86.92,85.37,77.49), and chroma (9.17,10.32,11.86), respectively. There were significant (*P*<0.05) differences the flours.

Table 4. *Color parameters of individuals, and composite flours.*

Flours	L*	a*	b*	WTI*	C*
WF	89.68±0.017[a]	0.42±0.01[g]	9.17±0.02[h]	86.92±0.24[a]	9.17±0.02[h]
AF	88.89±0.027[b]	0.82±0.02[f]	10.29±0.24[f]	85.37±0.05[b]	10.32±0.56[g]
GPF	76.51±0.06[g]	2.65±0.13[a]	11.56±0.46[d]	77.49±0.03[f]	11.86±0.15[f]
B	88.66±0.36[c]	1.33±0.08[cd]	15.26±0.37[e]	80.94±0.03[c]	15.31±0.21[e]
C	87.99±0.04[cd]	1.10±0.15[e]	15.51±0.07[bc]	80.35±0.02[d]	15.54±0.43[d]
D	85.57±0.26[d]	1.47±0.24[d]	16.10±0.06[c]	78.32±0.02[e]	16.17±0.06[c]
E	84.32±0.03[e]	1.73±0.23[c]	16.37±0.31[b]	77.27±0.03[g]	16.46±0.32[b]
F	83.16±0.05[f]	1.82±0.03[b]	16.95±0.29[a]	76.04±0.12[h]	17.05±0.12[a]

Values are means ± SD and values in the same column with different superscript letters are significantly different from each other (n=3, P < 0.05). L*=lightness, a*=redness-greenness, b*=yellowness WI= whiteness index. GPF-100% Grass pea flour, AF-100% Anchote flour, (A) WF-100% wheat flour; B-90% wheat flour + 5% anchote +5% grass pea flour; C-80% wheat flour + 10% anchote flour+10% grass pea flour; D-70% wheat flour + 15% anchote+ 15% grass pea flour; E-60% wheat flour + 20% anchote flour +20% grass pea flour; F-50% wheat flour + 25 % anchote+25% grass pea flour

These results might be observed that the L*, and WI values of the composite flour decreased, whereas, a*, b*, and chroma values increased. The highest and the lowest L* values were found of the sample A and F. Because the color of composite flour depends on grass pea, color values of flours decreased as protein content of grass pea flour increased. The high protein content of composite flour leads to decreasing color values [45]. The color results obtained for individual and composite flours in the present study were close to agreement with [34], who reported for different composite flours made from wheat and lentil flours, in which L*, a*, b*, and WI values ranged from (84.92-92.21), (-0.83-0.6), (11.65-17.57) and (64.61-85.96) respectively. Color is an important attribute of flour quality [46].

3.4. Pasting Properties of Grass Pea, Anchote, Wheat and Blends Flours

Pasting properties of grass pea, anchote, wheat and composite flours are summarized in Table 5. Peak viscosity is the maximum viscosity developed during or after the heat period of analysed. Starch is an essential ingredient in the creation of bread dough, particularly in the formation of the starch protein network. Peak viscosity (PV) is measured as the highest value of viscosity attained during the heating cycle (50-95ºC) of starch in flours. The pasting of flour is one of the most important properties influencing the quality of food that affects the texture, digestibility, and end-use of starch-based food commodities [47]. The highest peak viscosity was obtained for control wheat flour (1995cP) followed by grass pea (1699 cP) and anchote flour (1328cP). The peak viscosity of the composite flours ranged from 759 to 1529 cP. The highest peak viscosity composite flours for sample (B) 1529cP and the lowest peak viscosity observed for sample (F) 759cP are shown in Table 5. However, anchote-grass pea flour addition significantly decreased the peak viscosity of composite flours in the range of 759 to 1529cP. These results showed that there were significant differences (p<0.05) in the peak viscosity among the flours. The decrease in peak viscosity due to the high protein and fibre content in grass pea and anchote flours respectively.

The control (wheat flour) had the highest trough viscosity (1376 cP) and the lowest anchote (910 cP), followed by grass pea flour (462cP). There were significant (p<0.05) differences observed in the trough viscosity among the flours. Hold viscosity measures the viscosity when the swelled starch granules are disrupted upon shearing and heating. As shown in Table 5 indicated that blends sample B had the highest trough viscosity (1366cP) while the lowest was obtained for composite F (335cP). The trough viscosity decreased with increasing as substitution of anchote-grass flours. The trough is the minimum viscosity value, which measures the ability of paste to withstand breakdown during cooling [48].

Breakdown viscosity is the measure of the resistance to heat and shear of the flour. The breakdown viscosity values obtained ranged from (619 to 1688cP) among the individuals' flours. The highest breakdown viscosity value was observed for anchote flour (1688cP), followed by grass pea flour (1237cp) and lowest for control wheat flour (619cP). The breakdown viscosity was the highest composite E (905cP) and the lowest in B (163cP) compared to the control sample (619cP) were significant (P<0.05) different from each other. Therefore, the breakdown viscosity decreased with increasing levels of anchote-grass flours substitution. The high breakdown in viscosity implies the ability of the flours to withstand heating and shear stress during cooking [49].

The final viscosities of wheat, anchote and grass pea flours were 2182cP, 1768cP, and 823cP respectively Table 5 with significantly (P<0.05) difference between them. Wheat flour, final viscosity values. The flour sample from B had the highest (1603cP) final viscosity value and F flour had the lowest (604cP) final viscosity. The final viscosity of starchy foods, which reveals their propensity to create sticky paste after cooking and cooling [47]. The final viscosity decreasing with decreased levels of wheat flour substitution.

The setback viscosity ranged from (361.1 to 1765 cP) for wheat, grass pea, and anchote flours. Anchote flour had the highest (1765cP) setback viscosity from the other individual flours, whereas, wheat and grass pea flour were the lowest (806cP) and (361.1cP). There was significant difference (p<0.05) the wheat, grass pea, anchote flours. The setback viscosity of the flour composite flours increased significantly (P<0.05) as the proportion of anchote and grass pea flour increased from C (237 cP) to B (344 cP). Setback viscosity increased indicating its higher tendency to retrograde [50].

Table 5. *Pasting property of individuals and composite flour.*

Test	PV (cP)	Trough (cP)	BDV (cP)	FV (cP)	SB (cP)	PT (min)	PTemp (°C)
A (W)	1995±0.01^{a}	1376±0.12^{a}	619±0.01^{d}	2182±0.01^{a}	806.06±.085^{b}	6.92±0.01^{a}	60.05±0.0^{f}
AF	1328±0.013^{e}	910±.01^{d}	1688±0.08^{a}	1768±0.01^{b}	1765±.09^{a}	5.25±0.02^{g}	50.15±0.01^{h}
GPF	1699±0.41^{b}	462±0.01^{f}	1237±0.21^{b}	823±0.01^{e}	361.12±0.14^{c}	6.84±0.01^{b}	78.3±0.23^{a}
B	1529±0.11^{c}	1366±0.11^{b}	163±0.08^{h}	1603±0.01^{c}	237.1±0.16^{h}	6.82±0.14^{c}	63.5±0.02^{d}
C	1461±0.01^{d}	1205±0.2^{c}	256±0.24^{g}	1549±0.01^{d}	344±0.12^{d}	6.82±0.01^{c}	62.1±0.002^{e}
D	1241±0.01^{f}	776±0.01^{e}	905±0.08^{c}	605±0.70^{f}	254±0.11^{g}	5.39±0.01^{e}	54.96±0.01^{g}
E	1087±0.02^{g}	336±0.00^{g}	311±0.17^{f}	590±0.07^{h}	324±0.1^{e}	6.51±0.01^{d}	65.35±0.01^{c}
F	759±0.11^{h}	335±0.01^{h}	424±0.22^{e}	604±0.01^{g}	269±0.7^{f}	5.27±0.0^{f}	65.65±0.12^{b}

Values in the same row with different superscript are significantly different at (n=3, P<0.05). Values are means ± standard deviation Were, PV−Peak viscosity, BV−Breakdown viscosity, FV−Final viscosity, SB−Setback, PT−Peak time, P. Temp−Peak temperature. GPF-100% Grass pea flour, AF-100% Anchote flour, (A) WF-100% wheat flour; B-90% wheat flour + 5% anchote +5% grass pea flour; C-80% wheat flour + 10% anchote flour+10% grass pea flour; D-70% wheat flour + 15% anchote+ 15% grass pea flour; E-60% wheat flour + 20% anchote flour +20% grass pea flour; F-50% wheat flour + 25 % anchote+25% grass pea flour.

The pasting temperature for the individual flours were the highest in grass pea flour (78.3°C), followed by wheat (60.05°C) and anchote flour (50.15°C) as shown in Table 5. The pasting temperature was a significant (p<0.05) difference among samples. The pasting temperature of the composite flour ranged from 65.65 to 54.95°C with composite (F) being the highest (65.65°) pasting temperature, while composite (D) flour had the lowest (54.95°C) pasting temperature. Pasting temperature was measure of the minimum temperature required for cooking [51].

The peak time for the individual flours was the highest in wheat (6.92 min), followed by grass pea (6.84 min) and anchote (5.25 min) shown in Table 5. The peak time of the composite flours that were observed ranged from 5.27 to 6.82 minutes. The low peak time is indicative of its ability to cook fast, which may be recommended for certain products due to the low cost of energy [52].

4. Conclusions

The proximate composition (ash, crude protein and moisture content) and functional properties (bulk density, OAC, dispersibility,) increased significantly. This research shows that physiochemical analysis of the anchote, grass pea and wheat flours, as well as their composition. As a result, it is suggested that a value-added product with regard to health and nutritional elements be developed utilizing appropriate blends, as anchote-grass pea flour alone has some limits.

Conflict of Interest

The authors state that they have no conflict of interests.

Acknowledgments

Financial support provided by Bule Hora University is gratefully acknowledged. I would also like to thank the Debre Zeit Agriculture Research Center which provided me with an appropriate variety of grass peas and anchote crops, respectively. AASTU's Chemical Engineering and Food Engineering Departments are grateful for their keen interest and encouragement during the course of my research work in the laboratory.

References

[1] P. J. M. Pelgrom, R. M. Boom, and M. A. I. Schutyser, "Method Development to Increase Protein Enrichment During Dry Fractionation of Starch-Rich Legumes," *Food Bioprocess Technol.*, vol. 8, no. 7, pp. 1495–1502, 2015, doi: 10.1007/s11947-015-1513-0.

[2] S. M. Chisenga, T. S. Workneh, G. Bultosa, B. A. Alimi, and M. Siwela, "Dough rheology and loaf quality of wheat-cassava bread using different cassava varieties and wheat substitution levels," *Food Biosci.*, vol. 34, no. November 2018, p. 100529, 2020, doi: 10.1016/j.fbio.2020.100529.

[3] R. Amarowicz and R. B. Pegg, "Legumes as a source of natural antioxidants," *Eur. J. Lipid Sci. Technol.*, vol. 110, no. 10, pp. 865–878, 2008, doi: 10.1002/ejlt.200800114.

[4] E. Shiferaw, E. Porceddu, E. Pé, and M. Ponnaiah, "Application of CAPS markers for diversity assessment in grass pea (Lathyrus sativus L.)," pp. 11–18, 2017, doi: 10.1515/biorc-2017-0012.

[5] D. Tsegaye, W. Tadesse, and M. Bayable, "Performance of grass pea (Lathyrus sativus L.) somaclones at Adet, northwest," no. January, 2005.

[6] Y. Maphosa, "The Role of Legumes in Human Nutrition World s largest Science, Technology & Medicine Open Access book publisher," no. August, 2017.

[7] F. Lambein and Travella, "Grass pea (Lathyrus sativus L.): orphan crop, nutraceutical or just plain food ?," *Planta*, vol. 250, no. 3, pp. 821–838, 2019, doi: 10.1007/s00425-018-03084-0.

[8] N. M. Meybodi, L. Mirmoghtadaie, Z. Sheidaei, and A. M. Mortazavian, "Wheat Bread : Potential Approach to Fortify its Lysine Content Wheat Bread : Potential Approach to Fortify its Lysine Content," no. November 2020, 2019.

[9] K. Urga, H. Fufa, E. Biratu, and M. Gebretsadik, "Effects of blanching and soaking on some physical characteristics of grass pea (*Lathyrus sativus*)," *African J. Food, Agric. Nutr. Dev.*, vol. 6, no. 1, 2006, doi: 10.4314/ajfand.v6i1.19174.

[10] R. Tamburino *et al.*, "Nutritional values and radical scavenging capacities of grass pea (Lathyrus sativus L.) seeds in Valle Agricola district, Italy," vol. 6, no. 1, pp. 149–156, 2012.

[11] B. Kebede, K. Urga, and A. Nigatu, "Effect of processing methods on the trypsin inhibitor, tannins, phytic acid and ODAP contents of grass pea seeds," *Ethiop. J. Heal. Dvelopment. EJHD*, vol. 9, no. 2, 2017.

[12] Meseret, S. Admassu, C. Posten, and S. Andrée, "Reduction of β -ODAP and IP6 contents in Lathyrus sativus L. seed by high hydrostatic pressure Food Research International Reduction of β -ODAP and IP 6 contents in Lathyrus sativus L. seed by high hydrostatic pressure," *Food Res. Int.*, vol. 120, no. November 2020, pp. 73–82, 2019, doi: 10.1016/j.foodres.2019.02.011.

[13] A. Ababa, "Ethiopia: Second Country Report on the State of PGRFA Country Report on the state of PGRFA to FAO," 2007. Accessed: Oct. 23, 2020. [Online]. Available: www.ibc.gov.et/publications.

[14] Z. K. Akalu and S. H. Geleta, "Antinutritional Levels of Tubers of Colocasia esculenta, L. Schott (Taro) and Dioscorea alata (Yam) Cultivated in Ethiopia," *J. Nutr. Food Sci.*, vol. 07, no. 02, 2017, doi: 10.4172/2155-9600.1000585.

[15] Bekele, Endashaw, and I. Collaboration, "Study on Actual Situation of Medicinal Plants in Ethiopia," 2007.

[16] CSA, "The Importance of Legumes in the Ethiopian Farming System and Overall Economy : An Overview The Importance of Legumes in the Ethiopian Farming System and Overall Economy : An Overview," no. January, 2015, doi: 10.9734/AJEA/2015/11253.

[17] H. F. Aga and K. U. Badada, "Original article Nutritional and antinutritional characteristics of Anchote (Coccinia abyssinica)," 1997.

[18] B. D. Beruk, F. T. Tadesse, and H. Dereje, "Physical and Proximate Characterization of Anchote (Coccinia abyssinica) Accessions Grown under Hawassa and Wondo Genet Conditions, Southern Ethiopia," *Food Sci. Qual. Manag.*, vol. 42, no. September, pp. 62–75, 2015.

[19] Habtamu Fekadu, “Nutritional composition, antinutritional factors and effect of boiling on nutritional composition of Anchote (Coccinia abyssinica) tubers,” vol. 3, no. 2, pp. 177–188, 2014.

[20] E. D. Masarat, “Study on ethnobotany and phenotypic diversity in anchote (Coccinia abyssinica (Lam.) Cogn.) Landraces in western Ethiopia,” *Int. J. Agric. Sci.*, vol. 8, no. 2, pp. 1404–1427, 2018.

[21] A. Parmar, B. Agza Gebre, A. Legesse, Y. Demelash, K. Fladung, and O. Hensel, “Nutritional Comparison of White and Red Coccinia Abyssinica (Lam.) Cong. Accessions: An Under-Utilised Edible Tuber of the Ethiopian Highlands,” 2012, doi: 10.3390/foods6080071.

[22] T. A. Shittu, A. O. Raji, and L. O. Sanni, “Bread from composite cassava-wheat flour: I. Effect of baking time and temperature on some physical properties of bread loaf,” *Food Res. Int.*, vol. 40, no. 2, pp. 280–290, 2007, doi: 10.1016/j.foodres.2006.10.012.

[23] M. Noorfarahzilah, J. S. Lee, M. S. Sharifudin, A. B. Mohd Fadzelly, and M. Hasmadi, “Applications of composite flour in development of food products,” *Int. Food Res. J.*, vol. 21, no. 6, pp. 2061–2074, 2014, doi: 10.15740/has/ijae/11.sp.issue/65-69.

[24] J. Ndife, L. O. Abdulraheem, and U. M. Zakari, “Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends,” *African J. Food Sci.*, vol. 5, no. 8, pp. 466–472, 2011.

[25] M. A. I. Schutyser, P. J. M. Pelgrom, A. J. van der Goot, and R. M. Boom, “Dry fractionation for sustainable production of functional legume protein concentrates,” *Trends Food Sci. Technol.*, vol. 45, no. 2, pp. 327–335, 2015, doi: 10.1016/j.tifs.2015.04.013.

[26] A. O. Obadina, B. O. Babatunde, and I. Olotu, “Changes in nutritional composition, functional, and sensory properties of yam flour as a result of presoaking,” *Food Sci. Nutr.*, vol. 2, no. 6, pp. 676–681, 2014, doi: 10.1002/fsn3.150.

[27] S. C. Sgroppo, L. E. Vergara, and M. D. Tenev, “Effects of sodium metabisulphite and citric acid on the shelf life of fresh cut sweet potatoes,” *Spanish J. Agric. Res.*, vol. 8, no. 3, p. 686, 2010, doi: 10.5424/sjar/2010083-1266.

[28] E. Dako, N. Retta, and G. Desse, “Effect of Blending on Selected Sweet Potato,” *Glob. J. Sci. Front. Res. D Agric. Vet.*, vol. 16, no. 4, pp. 31–41, 2016.

[29] AOAC, “Analytical methods 1.,” pp. 94–100, 2000.

[30] S. Hussain, F. M. Anjum, M. S. Butt, and M. A. Sheikh, “Chemical composition and functional properties of flaxseed (Linum usitatissimum) flour,” *Sarhad J Agric*, vol. 24, no. 4, pp. 649–653, 2008.

[31] E. S. M. Abdel-Aal and F. W. Sosulski, “Bleaching and Fractionation of Dietary Fiber and Protein from Wheat-Based Stillage,” *LWT - Food Sci. Technol.*, vol. 34, no. 3, pp. 159–167, 2000, doi: 10.1006/fstl.2000.0741.

[32] Uzo-Peters, “Proximate composition and functional properties of composite sorghum-okara flour and sensory evaluation of local snack product (sosa),” *Agrosearch*, vol. 20, no. 1, pp. 158–167, 2020, doi: 10.4314/agrosh.v20i1.14s.

[33] E. R. Ohizua *et al.*, “Nutrient composition, functional, and pasting properties of unripe cooking banana, pigeon pea, and sweetpotato flour blends,” *Food Sci. Nutr.*, vol. 5, no. 3, pp. 750–762, 2017, doi: 10.1002/fsn3.455.

[34] O. Bouhlal, T. Mona, B. Nadia, A. Benali, A. Visioni, and J. Benba, “Wheat-lentil fortified flours: health benefits, phsicochemical, nutritional and technological properties,” *J. Mater. Environ. Sci.*, vol. 10, no. 11, pp. 1098–1106, 2019.

[35] I. MO and M. N, “Physicochemical and Pasting Properties High Quality Cassava Flour (HQCF) and Wheat Flour Blends,” *Agrotechnology*, vol. 06, no. 03, 2017, doi: 10.4172/2168-9881.1000167.

[36] C. G. Awuchi, “Proximate composition and functional properties of different grain flour composites for industrial applications,” *Int. J. Food Sci. Vol 2 No 1*, vol. 2, no. November 2019, pp. 43–64, 2019, [Online]. Available: https://www.iprjb.org/journals/index.php/IJF/article/view/1010.

[37] D. Girma and L. Korbu, “Genetic improvement of grass pea (Lathyrus sativus) in Ethiopia: An unfulfilled promise,” *Plant Breed.*, vol. 131, no. 2, pp. 231–236, 2012, doi: 10.1111/j.1439-0523.2011.01935.x.

[38] A. O. Adebayo-Oyetoro, O. O. Ogundipe, F. K. Lofinmakin, F. F. Akinwande, D. O. Aina, and S. A. O. Adeyeye, “Production and acceptability of chinchin snack made from wheat and tigernut (Cyperus esculentus) flour,” *Cogent Food Agric.*, vol. 3, no. 1, 2017, doi: 10.1080/23311932.2017.1282185.

[39] S. ur Rehman, A. Paterson, S. Hussain, M. Anjum Murtaza, and S. Mehmood, “Influence of partial substitution of wheat flour with vetch (Lathyrus sativus L) flour on quality characteristics of doughnuts,” *LWT - Food Sci. Technol.*, vol. 40, no. 1, pp. 73–82, 2007, doi: 10.1016/j.lwt.2005.09.015.

[40] Y. A. Adebowale, I. A. Adeyemi, and A. A. Oshodi, “Functional and physicochemical properties of flours of six Mucuna species,” *African J. Biotechnol.*, vol. 4, no. 12, pp. 1461–1468, 2005, doi: 10.4314/ajb.v4i12.71409.

[41] G. Doxastakis, I. Zafiriadis, M. Irakli, H. Marlani, and C. Tananaki, “Lupin, soya and triticale addition to wheat flour doughs and their effect on rheological properties,” *Food Chem.*, vol. 77, no. 2, pp. 219–227, 2002, doi: 10.1016/S0308-8146(01)00362-4.

[42] A. A. Akinola and S. N. Ezeorah, “Dehydration Studies of Root Tubers Using a Refractance Windows Dryer Dehydration Studies Of Root Tubers Using A Refractance,” no. June, 2018.

[43] P. Kaushal, V. Kumar, and H. K. Sharma, “Comparative study of physicochemical, functional, antinutritional and pasting properties of taro (Colocasia esculenta), rice (Oryza sativa) flour, pigeonpea (Cajanus cajan) flour and their blends,” *LWT - Food Sci. Technol.*, vol. 48, no. 1, pp. 59–68, 2012, doi: 10.1016/j.lwt.2012.02.028.

[44] M. J. Patel and S. Chakrabarti, “Flour quality and dough elasticity: Dough sheetability,” *J. Food Eng.*, vol. 115, no. 3, pp. 371–383, 2013, doi: 10.1016/j.jfoodeng.2012.10.038.

[45] S. Chevallier, P. Colonna, G. Della Valle, and D. Lourdin, “Contribution of major ingredients during baking of biscuit dough systems,” *J. Cereal Sci.*, vol. 31, no. 3, pp. 241–252, 2000, doi: 10.1006/jcrs.2000.0308.

[46] W. C. Sung and M. Stone, "Characterization of various wheat starch in pasta development," *J. Mar. Sci. Technol.*, vol. 11, no. 2, pp. 61–69, 2003.

[47] R. Juhász and A. Salgó, "Pasting behavior of amylose, amylopectin and their mixtures as determined by RVA curves and first derivatives," *Starch/Staerke*, vol. 60, no. 2, pp. 70–78, 2008, doi: 10.1002/star.200700634.

[48] E.-B. Onyeneke, "Functional And Pasting Properties of Products Of White And," vol. 17, no. 1, 2019.

[49] M. N. G. Amin *et al.*, "Functional and rheological properties of mixed flour from mangrove fruit of bruguiera gymnorrhiza flour and wheat flour," *Food Res.*, vol. 5, no. 1, pp. 167–173, 2021, doi: 10.26656/fr.2017.5(1).356.

[50] M. A. Ajatta, S. A. Akinola, and O. F. Osundahunsi, "Proximate, Functional and Pasting Properties of Composite Flours Made from Wheat, Breadfruit and Cassava Starch," *Appl. Trop. Agric.*, vol. 21, no. 3, pp. 158–165, 2016.

[51] Kiin-Kabari, "Functional and Pasting Properties of Wheat / Plantain Flours Enriched with Bambara Groundnut Protein Concentrate," *Int. J. Food Sci. Nutr. Eng.*, vol. 5, no. 2, pp. 75–81, 2015, doi: 10.5923/j.food.20150502.01.

[52] T. B. Verem, I. B. Dooshima, and E. M. Ojoutu, "Proximate, Chemical and Functional Properties of Wheat, Soy and Moringa Leaf Composite Flours," pp. 18–38, 2021, doi: 10.4236/as.2021.121003.