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Nutritional and Organoleptic Properties of Cookies Incorporated with Common Bean flour

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Abstract

Supplementation of cereals based food with legumes is an excellent vehicle for providing proteins, particularly in baked foods like biscuits, cookies, and cakes which are widely consumed due to their long shelf life and good eating quality. This research was conducted with the aim to develop and evaluate the nutritional quality of common bean based snack food (cookies) incorporated with wheat flour. The wheat-common bean flour blends were prepared by D-optimal mixture design software in five different blending ratios: T1 (50%Wheat: 50% Common beans), T2 (62.5wheat:37.5 common bean), T3 (75% wheat: 25 % common bean), T4 (87.5% wheat: 12.5% common bean and control (wheat 100%). Cookies were developed based on standards methods. Proximate compositions and functional property of composite flour were analyzed based on international standard methods. The highest values of ash content were recorded for T4(wheat 50% & common bean 50%) while the lowest values of ash content were noted for T1 (wheat control 100%). The protein content of wheat- cowpea composite flour was high in treatment T4 (wheat 50% &common-bean 50%) while low in T1 (wheat 100%)**.** The developed cookies were accepted by panelists even though their degree of preferences differs.Generally, cookies developed from wheat-common bean composite flour showed high content of protein and mineral contents. Therefore, incorporation of common bean in wheat based cookies might be used to tackle protein-energy malnutrition.

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Keywords

Proximate, cookies, legumes, wheat, common bean, nutrition.

Introduction

Legumes are well- honored functional foods and their use as constituents for food phrasings is getting adding attention. A number of studies has handed suggestions that consumption of legumes is associated with several physiological and health benefits, similar as forestallment of cardiovascular complaint, rotundity, diabetes mellitus and cancer (Liu *et al.,* 2022). Grain legumes play an important part in mortal nutrition, especially in the salutary pattern of low- income group in developing and limited income countries. Hence, supplementation with legumes is an excellent vehicle for furnishing proteins, particularly in baked foods like biscuits, eyefuls, and galettes which are extensively consumed due to their long shelf life and good eating quality (Dhull *et al.,* 2021). Utmost of snack foods are cereal- grounded and poor sources of protein (Berchie *et al.,* 2010). Snacks similar as doughnuts, pies, eyefuls among others which are generally produced from wheat flour have low nutritive values (Omah *et al.,* 2015). Choosing healthy snack foods is just as important at snack time as it's at mess time; thus it's possible to ameliorate the nutritive quality of cereal proteins by combination with leguminous factory protein sources (Noah *et al.,* 2019), similar as common- bean, chump pea, cowpea and soybeans amongst others. Eyefuls hold an important place in snacks due to its taste, terseness, and eating convenience. These are popular among all age groups especially in children. Generally, eyefuls are prepared from wheat flour, which are deficient in some essential amino acids like lysine and tryptophan (Chauhan *et al.,* 2016). Common bean (*Phaseolus vulgaris* L.) has significant artistic and literal significance as a staple food and is essential to mortal diets in numerous corridor of the world. Common- bean seeds are a good source of energy, complex carbohydrates (salutary filaments, bounce, and oligosaccharides), proteins, important minerals and vitamins (similar as iron, zinc, B-vitamins, folate) as well as antioxidants and polyphenols needed for mortal health. It also has the implicit to palliate malnutrition and hunger related problems as they're rich in quality globulin protein (20 - 28), energy (32), fiber (56) and micronutrients especially iron (70 mg/ kg) and zinc (33 mg/ kg) and vitamin A. Where diurnal bean consumption is high, it provides significant quantum of proteins, calories and micronutrients to avoid the consequences of malnutrition and hunger (Mahajan *et al.,* 2015). From a nutritive stage point, bean seeds are advanced in proteins than cereal grains (18-24 vs 8-15) and the amino acid profile of seed (storehouse) proteins well complements that of cereals, which are typically rich in sulfur aminoacids and poor in lysine, tryptophan and threonine (Sparvoli *et al.,* 2015). The nutritive value of cereal flours that are poor in lysine but rich in the sulphur containing amino acids is bettered by the addition of legume flours, and the nutritive value of root and tuber flours, which are poor in protein, is sufficiently bettered by the addition of cereal flours (Okpala *et al.,* 2011).

Legumes generally contain fairly high quantum of protein than other factory food stuffs. The consumption of cereal grounded foods like eyefuls at affordable cost requires the development of an acceptable cover for wheat (Saleh *et al.,* 2013). The cover should be one that's readily available, cheap and suitable to replace wheat flour in terms of functionality. Now a day, problem of protein- energy insufficiency is adding dramatically in babies. As it's formerly recommended in different inquiries, the practice of formulating/ compositing flours is a critical way of perfecting protein content of foods. Indeed however, there's acceptable vacuity of common bean kinds in Ethiopia, their application as a food component is undermined. Since the practice of incorporating common bean in diet through product development and invention isn't this important considered, there's a need to develop common bean grounded food products especially among the pastoral and civic poor in order to ameliorate the food, nutrition and health security benefits from sap. Thus, the main aim of this study was to develop common bean and wheat grounded eyefuls and estimate their nutritive and organoleptic quality.

Materials and methods

Study area

The experiments were conducted at Melkasa Agricultural Research Center in Food Science and Nutrition laboratory. The Center is geographically located at latitude of 8˚24’N, longitude of 39˚21’ E and at altitude of 1,550 meters. It is situated at about 107 km from Addis Ababa and 17 km from Adama on the way to Assela.

Sample collection and preparation

Popular wheat (*Shorima*) variety was collected from Kulumsa Agricultural research center. Wheat were first Sorted, cleaned, washed and dried on sunlight finally milled by milling machine.

Common bean (Roba variety) was collected from Melkasa lowland pulse research program. Common bean were sorted, cleaned, soaked overnight by hot water and dried on sunlight, and then grinded to remove bran, sorted and milled by hammer mill.

Formulations of Experimental Treatments

Formulation was done by D- optimal mixture design (design expert 7).

Development of Cookies

Cookies were developed based on the method of Rai *et al.,* (2014). The previously prepared flours of each composite were mixed with necessary ingredients. The oil (1 tea cup) and sugar (50g) were first poured in the blender and blended for 5 min. Then, baking (1 tea cup) and salt (0.5g) were dissolved in half volume of one eggs and milk (100ml) followed by addition of the vanilla (1 tea cup). The oil, sugar and other dry ingredients were kneaded and rolled. Then, the shaped cookies were put in the preheated the oven at 150ºC for 18 min and baked for 15 min at 130ºC and finally cooled for 10 min.

Functional properties

The oil and water absorption capacities were determined according to the method described by Ekeand Akobundu (1993). Swelling power (SP) and solubility were determined according to the method described by Ratnawati *et al.,* (2019).

Sensory analysis

Twenty un-trained but briefly oriented panelists about scoring of sensory attribute were assessed cookies for their acceptance. The samples were evaluated on nine (9) point hedonic scale method as described by (Khouryieh and Aramouni, 2012) and based on nine point hedonic scales: 1 (extremely dislike), 2 (dislike very much), 3 (dislike much), 4 (dislike), 5 (neither dislike nor like), 6 (like),7 (like much), 8 (like very much) and 9 (extremely like). The sensory attributes evaluated were surface color, surface cracking, texture, taste and overall acceptability.

Proximate Composition

Proximate compositions of composite flour and products have been determined by AOAC method.

Statistical Analysis

One-way ANOVA was used for statistical analysis. Generalized linear model (GLM) procedure for least square means and Duncan's Multiple Range Test (DMRT) for significant difference between means were used.

Results and Discussion

Functional properties

Functional properties of snack food (wheat – common bean) composite flours were presented in Table 3 below.

Functional properties of snack food (wheat-common bean) composite flours were presented in Table 1. According to the statistical analysis, there were no significant difference among treatments for WAC, OAC, and solubility while there was significance difference in terms of swelling power. The OAC is the binding of fat by the non-polar side chain of proteins. The 87.5 wheat & 12.5% common bean composite flours achieved high OAC. This can be related to the protein content in the composites which could be contributed by the incorporation of common bean proteins. It was observed that there is an increase in WAC for wheat 87.5% & common bean 12.5% composites as compared to control sample and other treatments. The swelling capacity is the measure of the starch ability to absorb water and swell. It is considered a quality measure in some food products such as bakery products (Iwe *et al.,* 2016). The highest value of swelling power was recorded for composite flour formulated from 62.5% wheat & 37.5% common bean. This formulation was found to be the optimum ratio where starch granules absorb high amount of water and swell up. This reveals that the starch from beans also contributed especially to the α-amylose and amylopectin ratio in turn the degree of swelling power of the composites improved. The previous study reported that the swelling power of Jack-bean flour was 6.24 (Idowu *et al.,* 2017). This result is higher than the result obtained for the composites flours in the current study. Being one of functional properties of the flours, solubility is usually determined during the development and testing of flour composite. The more soluble the flours, the more digestible it is in cells (Awuchi *et al.,* 2019). In this study, the solubility of composite flours showed that there was no significant difference among treatments. The study illustrated that the formulations containing only 12.5% common bean is more soluble than others. This could be due to the negative impacts of incorporation of common beans as it is less soluble/digestible than wheat.

Proximate composition

The proximate composition of wheat- common bean composite flours were presented in Table 4.

The proximate composition of composite flours is not significantly different from each other except for ash and carbohydrate contents. The highest value of ash content was recorded for 87.5% wheat-12.5% common followed by the control while the 50% wheat:50% common sample had the lowest ash content. The substitution of wheat flour with 12.5% common bean flour resulted in an increased in ash content because common bean is reach in minerals like Calcium, iron and zinc. Ash content is an indicator of total mineral present in a food sample. It was observed that there is no significant difference in moisture, fat, fiber and protein content among the composite flours. However, the 87.5 wheat & 12.5% common bean composite flour had the highest protein content which is 21.55%. The carbohydrate contents were ranged from 78.1165% to 66.3875%. It has been reported by Celmeli & Sari (2018) that the crude protein content of common bean flour was in the range of 16%-24% which is higher than the current result. It has been reported that 10% Unripe cooking banana:80% Pigeon pea: 10% Sweet potato composite flour had 17% protein content (Ohizua *et al.,* 2017).

Proximate compositions of Wheat-Common bean Cookies

The moisture content of wheat-common bean based cookies was ranged from 3.99 g/100g to 5.2 g/100g (Table 5). Addition of common bean to wheat flour increased moisture content when compared with 100% wheat flour (control). This is due to high protein content of common bean flour that holds more water. Crude protein content of wheat-common bean cookies was ranged from 11.55 g/100 to 14.05 g/100g. The composite flour with high ratio of common bean had high crude protein content when compared with other treatments. This is due to high protein content of common bean when compared to wheat. Aziah *et al.,* (2012), stated that inclusion of beans in wheat based foods increases the protein content of food products.

The crude fat content of cookies developed from composite flour of wheat and common bean ranged from 21.2g/100g to 25.13g/100g (Table 5). Cookies developed from equal amount of wheat and common bean flour showed high amount of fat content when compared with other treatments.

There were no significance differences among treatments in their crude fiber contents. The experiment showed that inclusion of common bean in composite flour increased crude fiber content of cookies. Cheng *et al.,* (2016) also found in their study that composite cookies had higher protein, fibre and ash compared to control cookies

The ash content of cookies developed from wheat-common bean composite flour ranged from 2.07g/100g to 3.49g/100g (Table 5). Cookies developed from equal ratio of raw ingredients (50% wheat and 50% common bean) had high amount of ash when compared with other treatments. Carbohydrate contents of wheat-common bean based cookies were ranged from 52.62g/100g to 60.97g/100g.

Ant nutritional factor

Legume seeds contain several anti-nutritional protein and non-protein compounds. The presence of these anti-nutritional factors is often the result of an evolutionary adaptation enabling survival and completion of plant life cycle (Duranti and Gius, 1997). Anti-nutritional factors of legumes can be factors affecting protein utilization and digestion, such as tannins and factors affecting mineral utilization, such as phytate.

The contents of tannin found in wheat-common bean were in the range of 0.0125-0.026 mg/g which is very low. However, the highest tannin (0.026 $g.100^{-1}$) and phytate (4.297 $g.100^{-1}$) content was recorded for 62.5% wheat & 37.5% common bean as compared to control and other formulations while lowest value was recorded for 75% wheat & 25% common bean. This shows that common bean incorporation in wheat flour contributed to a slight increase in anti-nutritional contents of the composite flours because the legumes have more anti-nutritional contents than cereals in nature.

The tannin result in this study is lower than that has been reported by other authors for cereal-legumes composite flours-based baked foods while the phytate content is higher. According to Moktan & Ojha (2016) tannin and phytate content of wheat:6% germinated horse gram flour bread was found to be 2.06mg/g and 2.46mg/g respective.

Sensory analysis

According to the statistical analysis, all treatments had gotten acceptance in terms of surface cracking even though their degree of preference differ. The highest sensory value of surface cracking was obtained for T3 (composite flour formulated from wheat 62.5% & common bean 37.5%) and lowest value for T2&4 (composite flour formulated from wheat 87.5% & common bean 12.5% and wheat 50% & common bean 50% respectively). The highest sensory value of color was obtained for T3 (composite flour formulated from wheat 62.5% & common bean 37.5%) and lowest value for T5 (composite flour formulated from wheat 75% & common bean 25%). The statistical analysis showed that there was no significance difference among the treatments in terms of their taste, texture and overall acceptance.

Table.1 Formulations of wheat and common-bean

Run	Wheat (%)	Common bean (%)
1	50	50
2	62.5	37.5
3	75	25
4	87.5	12.5
5	100	0

Table.2 Proximate analysis of composite flour

S.No.	Parameter	Analysis methods
1	Moisture content	AOAC (2000)
2	Crude protein	AOAC (2000)
3	Crude fat	AOAC (2000)
4	Crude fiber	AOAC (2000)
5	Ash content	AOAC (2000)
6	Total energy	Atwater and Benedict coefficients
7	Carbohydrate	Difference methods

Table.3 Functional properties of wheat-common bean composite flour

Treatments		**Parameters**		
	Water absorption capacity (WAC)	Oil absorption capacity(OAC)	Swelling power	Solubility
T1 (control)	0.667 ±0.058[a]	116.67±30.551[a]	3.128 ±0.669[ab]	8.333 ±2.93[a]
T2	0.767 ±0.289[a]	123.33±15.275[a]	3.637 ±0.791[a]	9.333 ±1.94[a]
T3	0.967 ±0.252[a]	143.33±15.275[a]	2.751 ±0.054[ab]	8.100 ±3.500[a]
T4	1.000±0.100[a]	120.00±26.458[a]	2.420 ±0.350[b]	9.833 ±0.737[a]
T5	0.800 ±0.100[a]	126.67±25.166[a]	2.854 ±0.173[ab]	8.533 ±1.872[a]
Grand mean	0.840	126.00	2.958	8.8267
CV	21.95	18.56	16.75	27.12

Note: T1 wheat control 100%, T2 wheat 87.5% & common bean 12.5%, T3 wheat 62.5% & common bean 37.5%, T4 wheat 50% & common bean 50% and T5, wheat 75% & common bean 25%.

Table.4 Proximate composition of composite flour

Treatment	Ash g/100g	Moisture g/100g	Crude protein g/100g	Crude fat g/100g	Crude fiber	Carbohydrate g/100g
T1	1.440±0.063[c]	7.200±0.378[a]	11.575±2.015[a]	1.667±0.033[a]	1.34±0.792[a]	78.116±6.364[a]
T2	1.557±0.060[c]	7.483±0.275[a]	18.171±0.578[a]	1.472±0.026[a]	2.010±0.269[a]	71.318±6.364[c]
T3	2.267±0.275[b]	7.350±0.087[a]	16.915±9.029[a]	1.055±0.535[a]	1.180±0.014[a]	72.318±849[b]
T4	3.500±0.198[a]	7.167±0.407[a]	21.554±0.477[a]	1.393±0.17[a]	2.145±0.318[a]	66.387±6.364[e]
T5	2.283±0.202[b]	7.583±0.058[a]	19.130±1.117[a]	1.603±0.071[a]	2.205±0.403a	69.401± 1.272[d]
Grand mean	2.22	7.357	17.466	1.438	1.776	71.527
CV	8.19	3.82	23.94	17.64	24.71	0.00

Note; T1 wheat control 100% ,T2 wheat 87.5% & common bean 12.5%, T3 wheat 62.5% & common bean 37.5% ,T4 wheat 50% & common bean 50% and T5, wheat 75% & common bean 25%.

Table.5 Proximate compositions of wheat-common bean based cookies

S. code	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)	Carbohydrates (%)
T1	4.325 ±0.672[ab]	11.550 ±0.212[c]	25.132 ±0.342[b]	1.975 ±0.347[a]	2.074 ±0.25[c]	56.928 ±0.014[b]
T2	4.575 ±0.035[ab]	12.350 ±0.212[bc]	22.955±1.816[c]	1.405 ±0.743[a]	2.324±8.22[c]	7.797±1.555[a]
T3	4.100 ±0.354[b]	11.850 ±0.354[c]	24.916 ±0.215[b]	2.125 ±0.191[a]	2.998 ±0.212[b]	56.135±1.484[c]
T4	3.975 ±0.106[b]	14.050 ±0.212[a]	25.858 ±0.215[a]	2.410 ±0.255[a]	3.499 ±1.24[a]	52.617±1.484[d]
T5	5.200 ±0.000[a]	13.000 ±0.566[b]	21.202 ±0.248[d]	2.105 ±0.078[a]	2.7872±0.018[b]	57.811±7.778[a]
Grand mean	4.435	12.560	24.012	2.004	2.737	56.258
CV	7.74	2.71	1.00	19.70	5.33	0.01

Note; T1 wheat control 100%, T2 wheat 87.5% & common bean 12.5%, T3 wheat 62.5% & common bean 37.5% ,T4 wheat 50% & common bean 50% and T5 wheat 75% & common bean 25%.

Table.6 Sensory analysis of wheat-common bean cookies

Treatments	Sensory Attributes				
	Surface cracking	Color	Taste	Texture	Overall acceptance
T1	6.688 ±1.778[ab]	6.625 ±1.858[ab]	6.313 ±2.120[a]	6.375 ±1.455[a]	6.250 ±1.807[a]
T2	5.188 ±2.198[c]	5.563 ±2.220[b]	5.563 ±2.337[a]	5.625 ±1.962[a]	5.875 ±1.628[a]
T3	7.250 ±0.683[a]	7.313 ±1.196[a]	5.813 ±1.471[a]	6.250 ±1.342[a]	6.500 ±1.033[a]
T4	5.188 ±1.721[c]	5.750 ±1.528[b]	5.250 ±1.291[a]	5.500 ±1.155[a]	5.625 ±0.957[a]
T5	5.625 ±1.857[bc]	5.375 ±2.277[b]	5.333 ±1.915[a]	6.125 ±1.668[a]	5.813 ±1.328[a]
Grand Mean	5.988	6.125	5.658	5.975	6.013
CV	28.8	30.39	33.01	25.80	23.12

Note; T1 wheat control 100%, T2 wheat 87.5% & common bean 12.5%, T3 wheat 62.5% & common bean 37.5%, T4 wheat 50% & common bean 50% and T5 wheat 75% & common bean 25%.

Fig.1 Preparation of wheat-common bean cookies

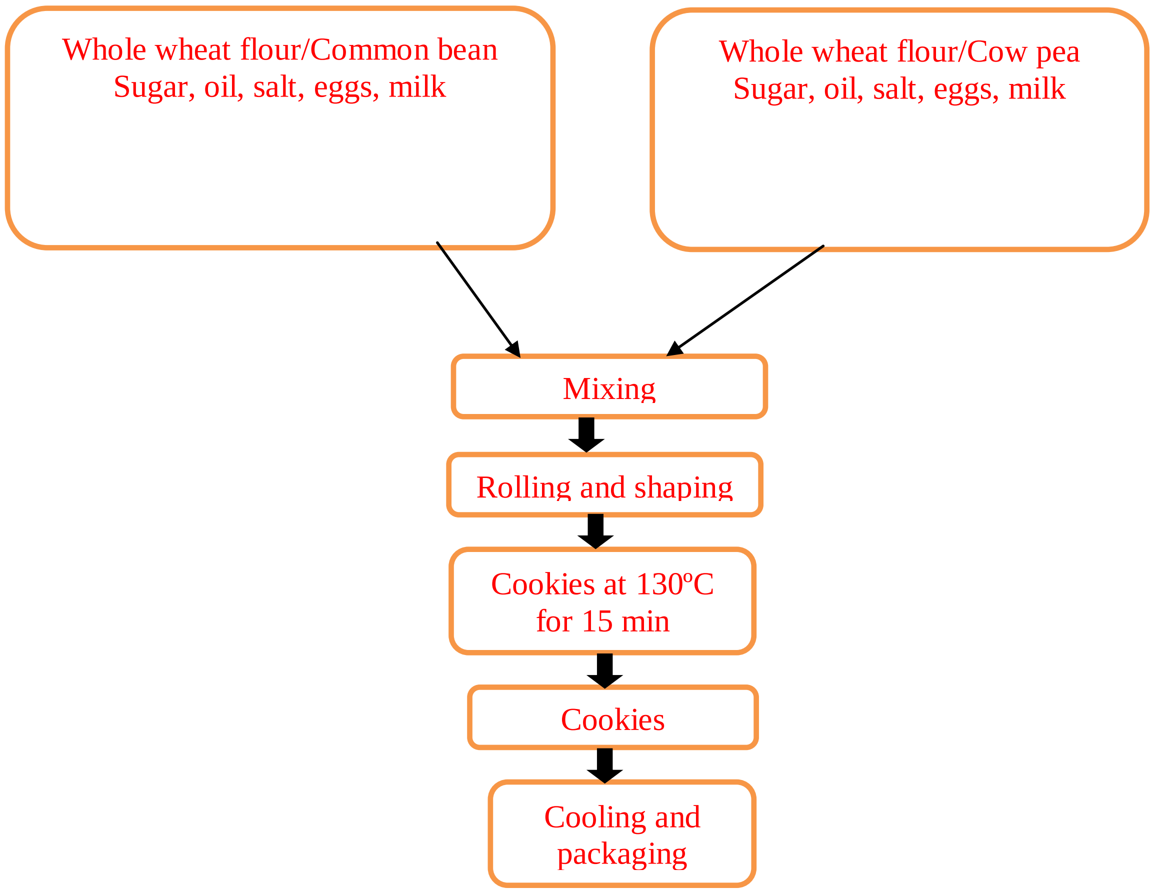


Fig.2 Phyate content of wheat common bean composite flour

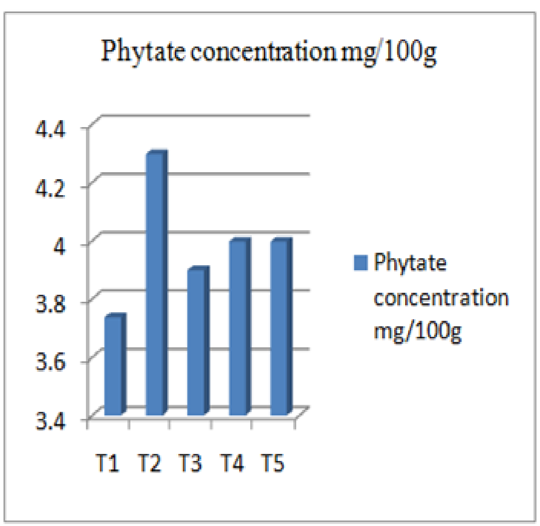
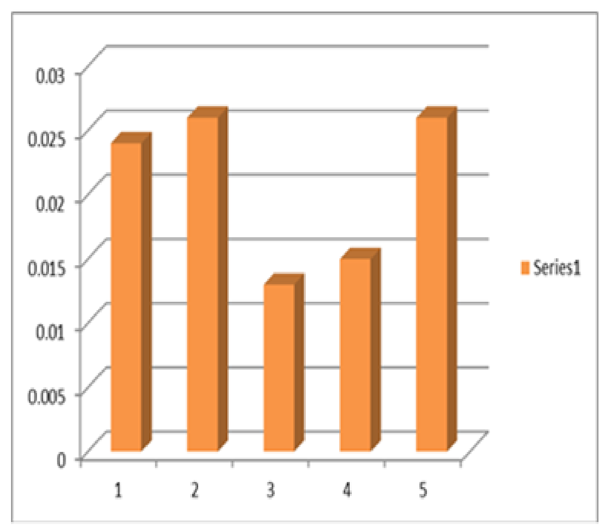


Fig.3 Tannin content of bean composite flour



Generally, cookies developed from wheat-common bean in treatment 3 and T1 more preferred by panelists. Benayad *et al.*, (2021) also found in their study that inclusion of beans in wheat based food product enhanced sensory acceptance. Our finding suggested that 37.5% is the appropriate ratio to increase nutritional value of cookies (surface cracking, color and overall acceptance) as well as their overall nutritional quality.

Supplementation of cereals based food with legumes is an excellent vehicle for providing proteins, particularly in baked foods like biscuits, cookies, and cakes which are widely consumed due to their long shelf life and good eating quality. This study showed that wheat-common bean composite flour had high water absorption capacity in a combination of wheat50%+ common bean 50% blending ratios. As the ratio of common bean incorporation increased, the water absorption capacity of composite flour increased. This might be due to the high protein content of common bean than wheat flour that absorbs more water. The highest ash value was obtained for the sample of wheat 50% & common bean 50% and while the lowest one was found in treatment1(wheat control 100%). This is due to high mineral content of pulse than wheat. The high ash value of the food sample is an indication of high mineral content. Regarding protein content the composite flour of wheat- common bean had showed high value for sample of wheat 50%: common bean (50%). AS the ratio of common bean in composite flour increased, the protein content of cookies increased. Even though all samples have been accepted by panelists, the highest sensory value of cookies was recorded for treatment 3 (wheat 62.5% & common bean 37.5%). Generally, incorporation of common bean in wheat based cookies has increased the ash and protein content. The researchers recommend inclusion of common bean in food products hence it helps to tackle protein-energy malnutrition and micro-nutrient deficiencies.

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