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Studies of Texture Profile Analysis (TPA), Physical and Sensory Attributes in Wheat and Cauliflower Flour Biscuits

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Abstract:

Background: Textural analysis is mainly done in food industry to determine the digestibility and to identify the sensory characteristics of food, and also to determine the general food texture profile that includes initial, masticate and the residual (undigested food) food in the body. There are many texture profile analysis (TPA) instrument widely available in the market. Objective: This study was carried out to produce biscuits made from different ratios (5, 10 and 20%) and different part s of cauliflower (stalk, leaves and flower) flour and wheat flours samples. Methods: In this study, replacement of wheat flour with cauliflower stalk flour (CSF), cauliflower flower flour (CFF) and cauliflower leaf flour (CLF) in baked biscuit products and their effect on texture profile, physical properties and sensory analysis were studied with the aim of talking advantage of potential value of the texture, physical properties and sensory evaluation from cauliflower flour. Results Additionally, it enhanced the spread ratio, density, and breaking strength of the biscuits. With a higher texture profile, better surface characteristics, and a better mouthfeel, these features may have experienced a positive change in sensory quality. The best flours in terms of both flour quality and biscuit quality were discovered to be 5% cauliflower stalk flour (CSF) and cauliflower flower flour (CFF). So, biscuit made from 5% of cauliflower stalk flour (CSF) and cauliflower flower flour (CFF) was found best with respect to biscuit quality as well as acceptability. Conclusion s : Interestingly, biscuit containing 5% cauliflower stalk flour received closely same score with the control score compared with other cauliflower (stalk, leaves and flower) for most of the sensory attributes judged. In conclusion, cauliflower flour (stalk, leaves and flower) flouer can be used as an alternative functional ingredient to partially replace wheat flour in biscuit formulation due to its ability to improve nutritional quality without compromising sensorial palatability. In future, it can be applied these results at industrial scale.

Keywords: Biscuit; Texture; physical; sensory; Cauliflower; flour.

Introduction:

Fresh white cauliflower (Brassica oleracea L. var. botrytis) is a good food choice since it is high in dietary fibre, antioxidants, and anti-cancer agents. Although the ratio of the inedible to the edible section after harvesting is high and gives off a foul odour when it decomposes, it also contains a significant amount of solid organic waste. And it now creates a major challenge: how to dispose of the leftover, inedible sections of cauliflower, which account for 45–60% of the vegetable's weight [1]. A few studies that addressed vegetable waste for food production, particularly cauliflower waste, led to the manufacturing of biscuits from cauliflower flour and its waste [2]. Ribeiro et al.,[3]. It has been demonstrated that biscuits made with cauliflower stalk flour (CSF) have a high level of fibre content and product acceptability. This lowers the consumption of wheat, which is expensive in Africa because it is scarce and primarily imported [4] Because biscuits come in a variety of varieties, are reasonably priced, and have good nutritional value, they are enjoyed by people from all walks of life [5]. Biscuits are typically manufactured with wheat flour and have a low moisture content (between 1 and 5%) and a lengthy preservation time [6].

It takes into account the sensory qualities of food (i.e., colour, texture, smell, taste, and appearance) and how those qualities interact with human senses to determine food senses, giving important information about the sensory qualities of food as well as preference/acceptance of a particular food. "The sensory and functional manifestation of the structural, mechanical, and surface properties of foods detected through the senses of vision, hearing, touch, and kinesthesia" is the definition of food texture. [7]. Texture has a big impact on food quality and can also affect how much nutrition is consumed. Food structure and composition are intertwined, and texture can be influenced by both the macroscopic and microscopic levels of structure. It is among the qualities that customers look for while determining the quality of cuisine.The texture of the food is one of the senses we experience when we eat. It could be described using terms such as "hard," "soft," "liquid," "solid," "rough," "smooth," "creamy," "crumbly," "crispy," "lumpy," "gritty," etc. There are also affects of ours on flavour. For example, thickness can alter

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the flavour of certain meals by slowing down the rate at which flavour and aroma leave them. If that meal were dissolved into a liquid, its flavour would be much more intense. One may argue that texture is a key factor in judging the quality of food [8, 9, 10].

The biscuit's quality is influenced by the kind and amount of ingredients used. When preparing biscuits, the main ingredients are wheat, water, sugar, oil, and salt. There is a relationship between the quality of the end product and the qualities of raw materials, particularly flour, as documented by many writers who have sought to explain how elements in a dough and the balance of the formula affect the final structure of the product [11, 12, 13, 14]. The type and amount of protein will differ based on the cultivar. De La Roche and Fowler [15] state that when the protein content was raised, the biscuits' baking length decreased. Unlike when baking bread, when the importance of the proteins—both in terms of quantity and widely recognized, it can be difficult to determine how gluten impacts the texture of biscuit dough. The use of gluten in the production of biscuits is the subject of very few reports. The National Research Centre (2020) produced the helpful test known as Texture Profile Analysis (TPA) to provide objective measurements of texture parameters, an essential component of food approval. The test was designed to mimic successive "chews" using a two-cycle compression measurement. The General Foods Texturometer was designed specifically to be used as a perfect substitute for the test. [9, 16, 17, 18]. As primary, masticatory (while chewing), and residual (pace of breakdown, type of breakdown) textural parameters, hardness, viscosity, and brittleness were recorded at first bite [19, 20, 9]. The original TPA standards, which were derived from Guinee (2003) and established by the General Foods Corporation group, are as follows: Hardness (N) Force required in order to generate a given deformation Force; The initial substantial curve force break is known as fractureability (N). cohesion (no unit): the degree of internal correlations within the sample; Work required to overcome adhesiveness (J), the force binding the sample to the probe; The amount of energy needed for food to go from being semi-solid to ready for eating. The amount of energy needed to chew a solid food before ingesting it (J) Cohesion*Hardness; Chewiness cohesiveness, rigidity, and elasticity; The speed at which a sample that has been distorted returns to its original dimensions is known as sprouting (m), formerly known as "elasticity"; The stringiness (m) of the material. Carbohydrates are difficult to define and identify because of their uneven structure and variable content. Once their nutritional contents are known [21, 22]. Particle size had an impact on the hardness and properties of gluten-free biscuits in relation to maize flour and wheat flour, as noted by Mancebo et al. [23]. While wheat biscuits have a significantly higher maximum strength, corn flour biscuits are equally available in all particle sizes.This is because wheat proteins are distinct from other types of proteins, and this influences the biscuit's texture and hardness. Protein and starch interact through hydrogen bonds in this way [24, 22]. In the Middle East, there are varieties of hard biscuits that are baked after being handmade. In order to aid in the fermentation process, the following substances are used in their manufacture: wheat flour, butter or margarine, water, salt, sugar, vanilla, and baking powder. After a brief period of kneading and spreading, biscuits take the shape of circular discs. Because biscuits are high in calories, minerals, and vitamins, and contain fibre and anti-inflammatory ingredients, they may be beneficial to your health. Standard tests for elasticity and pressure are among the basic analyses of the product that are carried out in order to confirm the quality characteristics of the product and its prior quality characteristics. The results of the mechanical study of the tissue by comparison with the trained human sensory strength revealed a significant correlation between the various sensory qualities, which is a measure of structural quality [9]. Since 1087, there has been a dearth of published scientific studies demonstrating the critical role that tissue plays in the automated evaluation of structural features. The goal of this study was to use automated assays to analyse the texture of biscuits made with different amounts of wheat flour and cauliflower flour, evaluate their sensory qualities, and examine their physical properties. This was done at the National Research Centre in Egypt because wheat biscuits are becoming more and more popular. Food technicians, with the assistance of texture analyzers, assess engineering performance and sensory quality throughout the manufacturing process [9]. As the structural properties, physical and sensory properties, and tactile parameters are important parameters of biscuit food properties, they are discussed in this research. This research dealt with the replacement of wheat flour with cauliflower flour.

Cauliflower flour (CFF), cauliflower leaf flour (CLF) and cauliflower stem flour (CSF) in baked biscuit products and their effect on sensory analyses, physical properties and texture appearance, in order to reach the potential values of physical properties, sensory evaluation and potential value of texture of cauliflower flour.

Methods:

Material and flour preparation:

Fresh white cauliflower (*Brassica oleracea L. var. botrytis*) variety was obtained in local distributor in Cairo, Egypt. Each whole cauliflower was separated at different three parts as follows: florets (edible portion), stalks and leaves midribs (non-edible portion) then weighed. All cauliflower samples were washed with subsequent drying in a ventilated oven at 40°C for 16h for stalks and florets samples and

40°C for 12h for leaves samples till moisture of 7-8% to obtain and milled using a Laboratorial disc mill (Quadrumat Junior flour mill or Model Type No: 279002, ©Brabender ® OHG, Duisburg 1979, Germany) to pass through a 60 mesh/inch sieve, until using. Cauliflower of stalk (CS), leaves (CL) and florets (CF) flours. Wheat flour (soft 72%) and other ingredients used in biscuits were obtained from the local markets.

Formulation of biscuits:

Preliminary studies (data not shown) have demonstrated the non-viability of CLF used for producing biscuits with little acceptable sensory characteristics. Biscuits were made with 3 different concentrations (0, 5, 10 and 20%) for each of cauliflower stalk flour (CSF), cauliflower flower flour (CFF) and cauliflower leaves flour (CLF), as seen in table (1). Whereas, the control sample made by 100% wheat flour (WF) as a soft 72%. The formulation of biscuits was obtained by fitting the original formulation described by **Perez and Germani [25]**.The percentage of cauliflower flour was increased relative to CS, CF and CL by facilitating the function of connecting dough. All dry ingredients were mixed together first, then the Fern butter, to form dough was added water gradually to the point of connecting to open the dough. Once this was obtained, types of dough were made in circular shapes of 5 cm in diameter to the biscuits.The biscuits were ordered directly in rectangular pans, and baked in an oven preheated or in a conventional oven at 160^0C for 20min, or until fully baked. The biscuits were left to rest to be packed in sealed plastic bags. Table (1) shows the formulation used to make the biscuits.

Physical properties Evaluation of wheat and Cauliflower Biscuits:

Measurements of physical characteristics **[26, 27, 28, 29]** of wheat and cauliflower biscuit samples were carried out. Five pieces of biscuits from each formulation were weighed simultaneously and the average weight (W) of each piece was noted. They were then placed edge-to-edge and stacked one above the other to measure the diameter (D) and thickness (T), respectively. Diameter of biscuits was measured by laying six biscuits edge-to-edge with the help of a scale. The same set of biscuits was rotated 90˚and the diameter was re-measured. Average values of biscuits were reported in centimetre. Thickness (T) of biscuits was measured by stacking six biscuits on top of one another and taking the average in centimetre. Diameter (D) was measured by Boclase (HL 474938, STECO, Germany)**.** Also, volume (V) and thickness (T) of biscuits were determined according to standard methods described in **A.A.C.C. (2000)[29].**The biscuits were rearranged and restacked and the average of the measurements was taken. The spread ratio and density of biscuits were derived from weight, diameter and thickness measurements. Spread ratio is equal to D/T. The spread ratio D/T was calculated by dividing the average value of diameter (D) by the average value of thickness (T) of biscuits. The spread ratio of the biscuit samples was determined, as described by **Gaines [30]**. Density was calculated by W/D2 and expressed as kg/m2. By following a common technique known as the threepoint break **[30]**, breaking strength and fracturability of biscuits were measured. Five biscuits edge to edge were used for the evaluation, and the average was noted.

Texture Profile Analysis:

Whole samples of biscuits were subjected to a unidirectional compression test to measure fracturability parameters: force at which the food started to break (kg. m2 s -2); and hardness: maximum force at which the product completely broke (kg. m2 s -2).

A texture analyser, Model CT3 10K using a Brookfield Engineering Lab. Inc., Texture Pro CT V1.6Build, serial Number 8662765 (made in USA) equipped with a 10000gm load cell. Test option and mode = compression force measurement, hold till time, protest speed = 2mm/s, test speed = 1.00mm/s, return speed = 1mm/s, and fixture=TA-MTP were the settings set. All biscuit samples were compressed with spindle 3R at a cross head speed 1 mm/sec to 5 cm of original diameter of the biscuits. The compression generated a curve with load (N) over time (min). The highest value of force (load) was taken as a measurement for hardness.

Fracturability attributes, breaking strength, hardness, adhesiveness, cohesiveness, springiness, resilience, chewiness and gumminess were evaluated **[19, 31, 32]**.

Sensory Evaluation of Wheat and Cauliflower Biscuits:

The panel was composed of ten panellists and staff from the Department of Food Technology in Food industries and Nutrition Research Institute, at National Research Centre. Ten training sessions were held prior to the test where panellists collaboratively developed aroma and flavour descriptors and standards. Taste, odour, Colour, texture, appearance and mouth feel of the wheat and cauliflower (steaks, leaves and flower) flour biscuits samples were determined using a ten-point scale (10 = excellent and 1 = bad) as described by **García et al., and Bertolini et al., [33, 34]**. The limit of the acceptability was 5. Samples were served in a randomized complete block design with all panellists evaluating all samples at one sitting. Each sample was presented with three-digit code. Random permutation principle was followed to determine serving order. Sample order presentation was randomized. Three replications were completed.

Statistical Analysis:

Data were presented as mean values of three replicates ± standard deviation (SD) which were subjected to one-way ANOVA. For comparison of means, the obtained results were analyzed statistically using the analysis of variance (ANOVA with two ways) and significant difference was determined at $p<0.05$ as described by **Richard & Gouri, and Silva & Azevedo, [35, 36]**.

Results:

Physical Properties of wheat and cauliflower (steaks, leaves and flower) flour biscuits:

The physical properties of biscuit have changed upon addition of cauliflower flour (steaks, leaves and flower) as seen in Table (2). There were no differences between diameters (mm) of biscuit with cauliflower flour (steaks, leaves and flower) and biscuit without cauliflower flour (steaks, leaves and flower). Mean thickness (mm) of control biscuit significantly differed with cauliflower flour (steaks, leaves and flower) biscuit, in which the control was thicker (0.93 mm) compared with cauliflower flour (steaks, leaves and flower) in range 0.67 to 0.83 mm decreased by increasing concentration cauliflower flour (steaks, leaves and flower). To calculate spread ratio was dividing diameter over thickness. Thus, spread ratio was lower in thicker biscuit than thinner biscuit, presented that the diameters of both biscuits are not different. Influence of cauliflower flour (steaks, leaves and flower) addition on spread ratio of biscuit was significant only at 5% level of incorporation. Spread ratio value (D/T) of 5% cauliflower flour (steaks, leaves and flower) biscuit was 5.95, 5.23 and 6.83 respectively while control WF was 5.77, as seen in table (2).

Table (2) showed that the volume of cauliflower flour (steaks, leaves and flower) biscuits decreased by increasing of the concentration of cauliflower flour (steaks, leaves and flower) in range 56-62 while volume of biscuit with wheat flour was 70. There were no differences between density kg/m^3 (W/D^2) of biscuit with cauliflower flour (steaks, leaves and flower) and biscuit control with wheat flour, as seen in table (2).

Texture Profile of Wheat and cauliflower (steaks, leaves and flower) flour biscuits:

Curves (1) demonstrated the variations in texture advantages between the wheat flour biscuit samples (WF, CSF, CLF, and CFF) and the cauliflower flour biscuits predicted by texture profile analysis The fracturability and hardness the cauliflower flour biscuits (steaks, leaves, and flowers) ranged from 42.53 to 98.33 N, which was higher than that of the wheat flour biscuit control, which had a value of 33.85 N. These findings are displayed in table (3) and the curves in figure (1).

Table (3) and the curves in Figure (1) demonstrate how springiness and resilience were gradually reduced as the amount of cauliflower flour (steaks, leaves, and flowers) was increased, with a range of 1.81-3.60mm inclusion control biscuit . Table (3) and the curves in Figure (1) show that the biscuits with 5% and 20% CFF formulation had decreased springiness (1.35 and 1.06), which differed substantially from the control (1.74mm). Table (3) and the curves in Figure (1) show that the resilience was not significantly impacted by any of the cauliflower (steaks, leaves, and flower) flour biscuit samples in the range of 0.01-0.04 when compared to 0.02 in the substantially less cohesive in the range of 0.03–0.08 than the control's 0.06, suggesting that the former is superior. Table (3) and the curves in Figure (1) show that the CSF was 0.1 and 0.13 cohesive, with the exception of 5% and 10%. control biscuit.

As can be seen in table (3) and curves in figure (1), adhesiveness (g•cm) was not significantly affected by some samples of 10% CSF, 10% and 20% CLF, and 5%, 10%, and 20% CFF biscuits in the range of 1–5 g.cm. However, it was in the range of 14–27 g.cm by other samples of CSF, CLF, and CFF biscuit compared with 9 g.cm in control biscuit.

Table (3) and the curves in Figure (1) show that chewiness (g•cm) was in the range of 100-165g•cm for some samples of CSF and CFF biscuit compared with 34g•cm for the control biscuit. However, chewiness (g•cm) was not significantly altered by samples of 5%, 10%, and 20% CLF and 5% CFF biscuits in the range of 23-43g•cm. Newton (N) is used as the unit. As can be observed in table (3) and the curves in figure (1), gumminess was also not significantly impacted by some samples of 5%, 10%, and 20% CLF and 5% CFF biscuits in the range 1.25-1.85N, but was in the range 4.66-9.54N by other samples of CSF and CFF biscuit compared with 1.91N in the control snack. The quality of several textural qualities of the biscuits has been lowered in the sample of 5%, 10%, and 20% CLF and 5% CFF biscuits; however, the alterations are highly pleasing as indicated by the sensory evaluation score for texture characteristic, as shown in table (4).

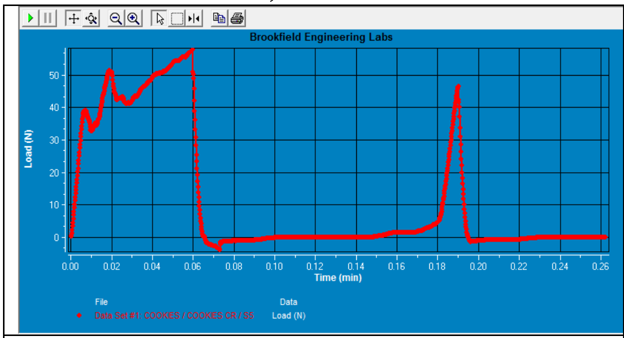
Sensory evaluations of wheat and cauliflower (steaks, leaves and flower) flour biscuits:

Sensory evaluation assist in the clearly of qualities product that are marked in terms of customer accept. To evaluate the sensory quality of the final product, sensory aspects like color, texture, taste, odour, mouth feel and appearance were evaluated (Table 4).

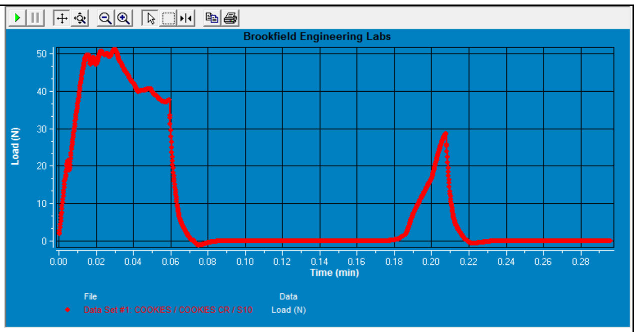
Table (4) indicates the intermediate data from the sensory tests (texture, odour, taste, color, appearance and mouth feel) on the biscuit with cauliflower flour (steaks, leaves and flower) samples and biscuit without cauliflower flour or compares them to 100 % wheat flour commercial.

All sensory characteristics (odour, colour, taste, texture, appearance and mouth feel) score of 5% of CSF biscuit formulations and wheat flour biscuit had the highest hedonic score with the same statistical degree a (8.11-8.6[a] and 8.6-8.9[a], respectively) among all other cauliflower (steaks, leaves and flower) flour formulations biscuit, as seen in table (4). Control biscuits scored higher (8.6-8.9) than biscuits supplemented with 10% of CSF and 5% of CFF biscuit formulations (7.8-8) in term of odour, colour, taste, texture, appearance and mouth feel, among all other cauliflower (steaks, leaves and flower) flour formulations biscuit, as seen in table (4).

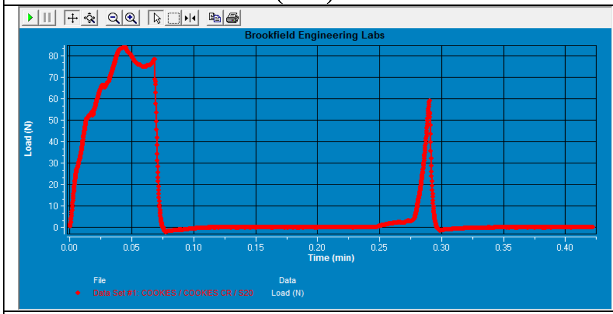
On the contrary, biscuit combinations of 20% of CSF, CLF and CFF has lower scores for all sensory characteristics compared with control and 5% CSF combinations. Whereas, our results on biscuits mixed with cauliflower (steaks, leaves and flower) flour combinations biscuit had also indicated that 5% CSF was highly acceptable, but decrease in score was noted for higher percentage of other cauliflower (steaks, leaves and flower) flour combinations biscuit, as seen in table (4).



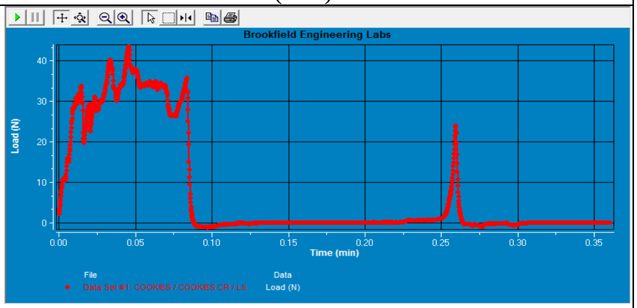
5% cauliflower stalk flour (CSF) biscuit



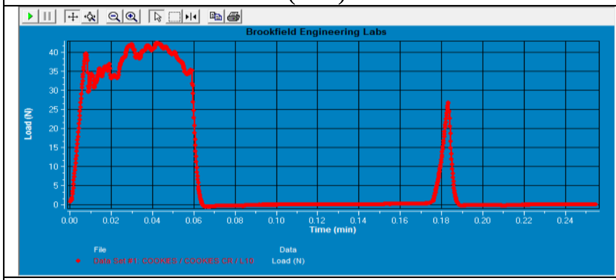
10% cauliflower stalk flour (CSF) biscuit



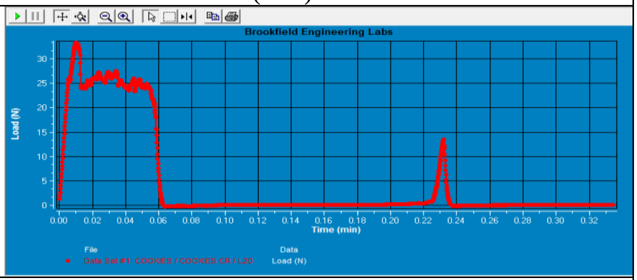
20% cauliflower stalk flour (CSF) biscuit



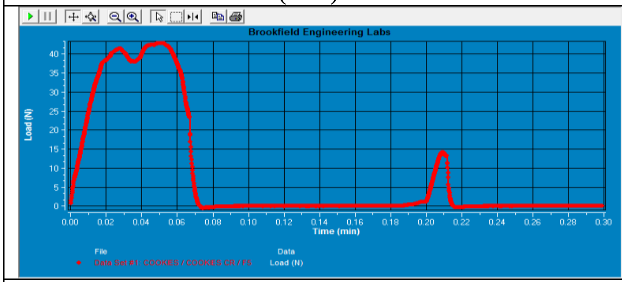
5% cauliflower leaf flour (CLF) biscuit



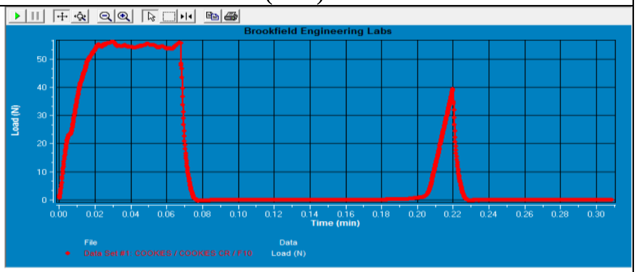
10% cauliflower leaf flour (CLF) biscuit



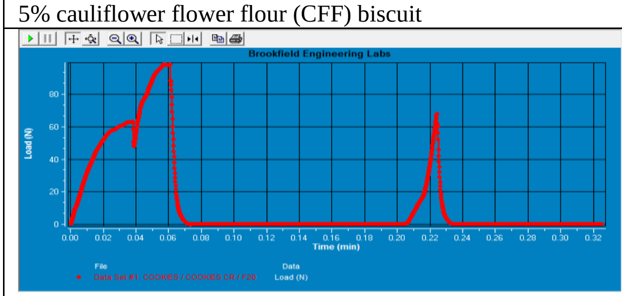
20% cauliflower leaf flour (CLF) biscuit



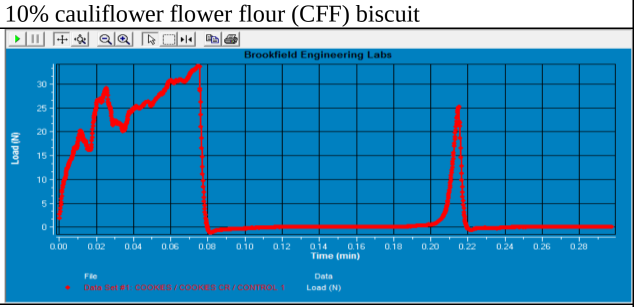
5% cauliflower flower flour (CFF) biscuit



10% cauliflower flower flour (CFF) biscuit



20% cauliflower flower flour (CFF) biscuit



100% Wheat flour (WF) biscuit as a Control

Figure (1): Curves for texture parameters of wheat (WF) and cauliflower (CSF, CLF and CFF) flour biscuits.

Table (1): Replacing the wheat flour with cauliflower flour with different ratio.

Ingredients (grams)	Replacing the Wheat Flour with Cauliflower Flour			
	WF	CSF	CLF	CFF
*Cauliflower flour (CSF), (CLF) and CFF)	0	5	10	20
*Wheat flour (WF) soft, 72%	100	95	90	80
Sugar	57	57	57	57
Butter	28	28	28	28
Baking Powder	1	1	1	1
Salt	1	1	1	1
Vanilla	1	1	1	1
Water	7	7	7	7

*Cauliflower of Stalk flour (CSF), Leaves flour (CLF) and Flower flour (CFF) and Wheat Flour (WF).

Table (2): Physical properties of wheat and cauliflower (steaks, leaves and flower) flour biscuits.

	Volume (V)	**Diameter (D, cm)**	**Thickness (T)**	**Weight (W, gm)**	**Diameter (D^2)**	**Density (gm/cm^2)**	**Spread ratio (D/T)**
WF - Control	70	5.37	0.93	17.19	28.84	0.60	5.77
CSF 5%	70	5.17	0.87	17.93	26.73	0.67	5.95
CSF 10%	56	5.37	0.90	17.04	28.84	0.59	5.97
CSF 20%	56	5.30	0.66	18.87	28.09	0.67	8.03
CLF 5%	68	5.23	1.0	17.13	27.35	0.62	5.23
CLF 10%	66	5.57	0.83	17.22	31.02	0.55	6.71
CLF 20%	62	5.60	0.83	16.48	31.36	0.52	6.75
CFF 5%	64	5.67	0.83	18.91	32.15	0.59	6.83
CFF 10%	60	5.57	0.80	17.76	31.02	0.57	6.96
CFF 20%	56	5.73	0.66	18.91	32.83	0.58	8.68

Table (3): Texture parameters of wheat and cauliflower (steaks, leaves and flower) flour biscuits.

Texture Parameters	**CSF 5%**	**CSF 10%**	**CSF 20%**	**CLF 5%**	**CLF 10%**	**CLF 20%**	**CFF 5%**	**CFF 10%**	**CFF 20%**	**WF 100% (Control)**
Hardness Cycle 1: N	57.64	51.14	83.85	43.58	42.53	33.31	42.91	56.23	98.33	33.85
Deformation at Hardness: mm	3.50	1.68	2.53	2.69	2.46	0.56	3.01	1.71	3.28	4.47
Deformation at Hardness: %	6.40	3.10	4.40	5.20	4.30	1.00	5.80	3.30	6.30	8.10
Hardness Work Cycle 1 g·cm	1574.00	1447.00	2607.00	1550.00	1261.00	854.00	1383.00	1963.00	2090.00	1098.00
Recoverable Deformation Cycle: mm	0.24	0.72	0.24	0.23	0.01	-0.09	0.00	0.38	0.30	0.17
Recoverable Work Cycle 1 g·cm	41.00	56.00	41.00	19.00	35.00	35.00	49.00	71.00	76.00	27.00
Total Work Cycle1: g·cm	1615.00	1503.00	2649.00	1569.00	1296.00	888.0	1432.00	2034.00	2166.00	1125.00
Load at Target: N	57.64	37.63	78.21	35.77	35.31	21.83	26.83	55.81	98.07	33.85
Deformation at Target: mm	3.50	3.50	3.99	5.00	3.47	3.38	3.88	3.00	3.49	4.47
Deformation at Target: %	6.40	6.40	7.00	9.60	6.10	6.00	7.50	7.60	6.70	8.10
Peak Stress: dyn/cm²	9060592.00	8038616.50	16679303.00	5548861.00	11052869.00	8657274.00	8536682.00	11185863.00	25553866.00	5321055.50
Strain at Peak Load:	0.06	0.03	0.04	0.05	0.04	0.01	0.06	0.03	0.06	0.08
Adhesive Force: N	3.85	1.15	2.10	1.20	0.54	0.31	0.53	0.43	0.17	1.16
Adhesiveness: g·cm	27.00	5.00	19.00	14.00	5.00	3.00	2.00	3.00	1.00	9.00
Resilience:	0.03	0.04	0.02	0.01	0.03	0.04	0.04	0.04	0.04	0.02
Stringiness Length: mm	0.45	0.16	0.12	0.50	0.19	0.07	0.07	0.05	0.04	0.12
Stringiness Work Done: g·cm	11.00	1.00	1.00	5.00	1.00	0.00	0.00	0.00	0.00	1.00

Texture Parameters	CSF 5%	CSF 10%	CSF 20%	CLF 5%	CLF 10%	CLF 20%	CFF 5%	CFF 10%	CFF 20%	WF 100% (Control)
Quantity of Fractures: with 1% of load sensitivity	4.00	7.00	4.00	23.00	15.00	19.00	2.00	2.00	1.00	14.00
Fracturability: N with 1% of load sensitivity	39.02	21.54	53.64	11.07	39.62	25.87	41.43	55.28	63.06	16.89
1st Fracture Load Drop Off: N with 1% of load sensitivity	6.43	2.76	1.77	0.35	10.04	0.66	3.41	0.73	15.17	0.53
1st Fracture Work Done: g·cm with 1% of load sensitivity	84.00	32.00	340.00	14.00	73.00	43.00	460.00	446.00	973.00	56.00
1st Fracture Deformation: mm with 1% of load sensitivity	0.37	0.25	0.97	0.18	0.39	0.30	1.60	1.24	2.17	0.49
1st Fracture %Deformation : with 1% of load sensitivity	0.70	0.50	1.70	0.30	0.70	0.50	3.10	2.40	4.20	0.90
Hardness Cycle2: N	46.52	28.69	58.92	24.04	26.82	13.52	14.19	39.34	67.79	25.28
Hardness Work Cycle 2: g·cm	154.00	18.9.00	194.00	45.00	55.00	30.00	53.00	163.00	202.00	62.00
Cohesiveness:	0.10	0.13	0.07	0.03	0.04	0.04	0.04	0.08	0.10	0.06
Recoverable Deformation Cycle 2: mm	0.21	0.67	0.25	0.25	0.25	0.23	0.11	0.42	0.49	0.20
Recoverable Work 2: g·cm	28.00	40.00	39.00	15.00	16.00	8.00	24.00	38.00	51.00	13.00
Total Work Cycle 2: g·cm	181.00	228.00	233.00	59.00	71.00	38.00	77.00	201.00	253.00	76.00
Springiness: mm	2.48	1.81	2.59	3.60	1.91	2.36	1.35	2.10	1.06	1.74
Springiness Index:	0.71	0.52	0.65	0.72	0.55	0.70	0.35	0.53	0.30	0.39
Gumminess:N	5.63	6.67	6.25	1.25	1.85	1.17	1.64	4.66	9.53	1.91
Chewiness: g·cm	142.00	123.00	165.00	46.00	36.00	28.00	23.00	100.00	103.00	34.00
Chewiness Index:N	4.00	3.47	4,06	0.90	1.02	0.84	0.58	2.47	2.86	0.75
Corrected Cohesiveness:	0.08	0.11	0.06	0.02	0.03	0.03	0.02	0.07	0.08	0.05
Corrected Gumminess:N	4.75	5.48	5.09	0.85	1.35	0.90	0.93	3.70	7.41	1.54
Corrected Chewiness: g·cm	120.00	101.00	134.00	31.00	26.00	22.00	13.00	79.00	80.00	27.00
Average Peak Load: N	52.08	39.92	71.38	33.81	34.68	23.42	28.55	47.79	83.06	29.57
Sample Length: mm	55.00	55.00	57.00	52.00	57.00	56.00	52.00	52.00	52.00	55.00

Table (4): Sensory evaluation of of wheat and cauliflower (steaks, leaves and flower) flour biscuits.

	Taste	**Odour**	**Color**	**Texture**	**appearance**	**mouth feel**
WF - Control	8.9^{a} (0.88)	8.6^{a} (0.7)	8.89^{a}(0.88)	8.67^{a}(1.66)	8.9^{a} (0.57)	8.9^{a} (0.57)
CSF 5%	8.2^{a} (0.92)	8.5^{a} (0.71)	8.56^{a}(0.85)	8.11^{a}(1.76)	8.6^{a} (1.43)	8.2^{a} (0.79)
CSF 10%	7.6^{b} (1.17)	7.9^{b} (0.99)	8^{b} (1.63)	7.67^{C}(1.73)	8^{b} (1.33)	7.9^{b} (0.99)
CSF 20%	6.9 (0.99)	6.8 (1.03)	6.33^{d}(1.35)	6.44 (1.23)	6.9 (1.2)	6.9 (0.88)
CLF 5%	7^{C} (0.94)	6.2^{d} (1.4)	5^{d} (1.66)	^{C} (1.22)	5.7^{d} (1.4)	6.9^{C} (1.6)
CLF 10%	6.4^{d} (1.07)	5.8^{d} (1.55)	4.44^{d}(1.84)	6.56^{d}(1.51)	5.6^{d} (1.7)	6.7^{d} (1.6)
CLF 20%	5.5^{d} (1.35)	5.1^{d} (1.73)	3.56^{d}(1.87)	5.78^{d}(1.79)	4.8^{d} (2.1)	6^{d} (2.1)
CFF 5%	7.8^{b} (1.4)	7.9^{b} (1.45)	8^{b} (1.15)	8^{b} (1.22)	7.8^{b} (1.4)	7.9^{b} (1.67)
CFF 10%	7.1^{C} (0.88)	7.6^{C} (0.84)	7.78^{C} (1.1)	7.67^{C} (1.0)	7.9^{C} (0.74)	7.7^{C} (1.25)
CFF 20%	6.6^{d} (1.17)	7.2^{C} (1.14)	6.78^{d}(1.25)	7^{C} (1.32)	7.2^{C} (0.92)	7^{C} (1.05)

*Means (±SD) followed by different superscripts within each column are significantly different ($p \leq 0.05$).

Discussions:

Physical Properties of wheat and cauliflower (steaks, leaves and flower) flour biscuits:

The previous results in table (2) indicated that the cookies or the biscuit with higher value of spread ratio were more advisable **[37, 38, 39]**. Identical results to those found in this work were notified by **Anis et al; [28]**.

Texture Profile of Wheat and cauliflower (steaks, leaves and flower) flour biscuits:

Texture profiles were identify by Double-bite compression tests. In exert, the texture properties have two most important factors are deformation (strain) and force (stress). while, cohesiveness, chewiness,g umminess, adhesiveness and firmness were parameters to measures Texture Profile Analysis (TPA) [9, 40]. It is defined that texture has a vibrant role in the quality of biscuits, and it is hard affected by their components.

Friedman et al., **[41],** defined the original parameters from the curve given and a discussion on their improvements is given below.

Hardness is the most essential factor in determine the biscuit texture. It is used to determine the firmness of biscuit and is known as the force required achieving a specific deformation **[9]**. **Fracturability** (FR) is identified in the curve as the force at the first significant break **[10, 41].** Also**, Hardness** (HA) is declared as the peak force (i.e., force required to get a given deformation) during the first compression cycle conceived as the first bite.

However, when it came to fracturability and breaking strength, there were no changes between the control biscuit and the cauliflower flour biscuits (steaks, leaves, and flowers). Nevertheless, breaking strength, which quantifies the greatest force required to split the biscuit in half using the instrument, relates to the hardness of the biscuit. Higher value so indicated that the biscuit is harder. In the interim, fracturability refers to the biscuit's resistance to bending. The distance at which the biscuit breaks—referred to as fracturability—was found in the results. If it shatter at a closer distance, biscuit has a greater fracturability. However, a substantial difference was only noticed after 20% integration of CLF (33.31N). It's possible that harderness rose when fat content decreased. The dietary fibre in cauliflower flour (steaks, leaves, and flowers) has replaced wheat flour in biscuits, increasing their hardness as a result of their increased density. In another study, the substitution of peach dietary fibre for wheat flour resulted in harder biscuits because there were less air spaces and more density. **[42]**.

Springiness (SP) is a measure of the repound after the first compression. It is an signal of the recovery during the time that elapsed between first bite end and second bite start (originally called elasticity). Also, **Resilience (RE)** is the immediate springiness since it is measured on the pulled out the first penetration before the waiting interval **[10]**. **Springiness** is known as the rate of the sample repounds to its original dimensions after eliminated deforming force **[9]**. A decrease in springiness has been linked to a denser matrix and fewer air bubbles in the biscuit [43]. A biscuit's bio property known as "springiness" describes its capacity to regain its height in the interval between the end of the first compression and the beginning of the second. There was a substantial difference in the resilience values between the cauliflower (steaks, leaves, and flower) flour biscuits and the control group. Resilience is the product's capacity to rebound after deformation; a decrease in resilience with adding cauliflower flour (steaks, leaves, and flowers) may be the result of the product's dense matrix. **[44]**.

During the second compression to the first compression the ratio of positive force area is named **Cohesiveness (CO)** (i.e., strength of the internal bonds making up the body) **[10]**. Cohesiveness, which gauges the strength of internal linkages, is the degree to which a material can deform before rupturing [9]. It is relevant to customer acceptance of biscuits and a crucial characteristic for assessing the texture of the biscuits. In addition to measuring perceptions of biscuit density, cohesiveness also accounts for sensory crumbliness and the amount of effort required to chew the food item [43]. Our observations indicate that biscuits with a higher amount of cauliflower flour (steaks, leaves, and flower) broke more easily when handled.

The work required to pull the compressing plunger far from the sample representing the negative force area to the first bite which call as **Adhesiveness (AD) [10]**. Adhesiveness is defined as the force wanted to remove the stuck substance from the mouth during chewing.

Chewiness (CH) is relevant to the basic parameters of cohesiveness, elasticity and hardness . It is identify as the product of springiness and gumminess (=cohesiveness× springiness× hardness) as described in **[10, 41]**. Another necessary parameter for biscuit textural research is its gumminess. The level of gumminess approval in biscuits depends on the consumer approval. It may different from person to person **[9]**. **Gumminess** (GU) is defined as the product of cohesiveness and hardness **[10]**. In table (4) identical results to those found in this work were notified by **Anis et al; [28]**.

This finding established that the science of the texture of cauliflower flour biscuits (steaks, leaves, and flowers) lies in the optimisation of the amount of water and sugar utilised in the dough composition, as well as in the way different components of the biscuit interact to make up for the lack of gluten. maintains the cohesion of the biscuit owing to the sugar glass matrix and holds the biscuit matrix together. The hardness of cauliflower (steaks, leaves, and flowers) flour biscuits is indicated by the strength of the nets made of starch granules in sugar glasses [45].

The soft texture and open structure of the cauliflower flour biscuits (steaks, leaves, and flowers) were caused by air bubbles in the margarine being trapped during creaming. This resulted in a weak biscuit structure. This confirms that the selection of ingredients affects the texture of cauliflower flour biscuits (steaks, leaves, and flowers), just like it does for wheat biscuits. It is unclear how the various cauliflower components—steaks, leaves, and flowers—flour and dough genuinely contribute to the formation of biscuit texture [45].

Sensory evaluations of wheat and cauliflower (steaks, leaves and flower) flour biscuits:

Concurrently, other research of biscuit mixed with corn derivatives had also noted that 10% mixing level was highly acceptable, but decrease in score was noted for higher percentage of mixing level **[46]**. Other ways to say that the same results to those found in this work were informed by **Bello et al., [47]** during sensory evaluation of two kinds of biscuits processed from banana starch, as indicated by **Canett et al., [48]** during the sensory evaluation of biscuits processed from husk grape. While **Cori and Pacheco [49]** also sweet biscuits as wafer with sunflower flour defatted sensory evaluated and agreeable good found in terms of odour, colour, hardness and flavour parameters. Along the same lines, **Garcia and Pacheco [50]** sensorial evaluated several components of biscuits basis on Arracacha flour and comparison with a standard processed with business wheat flour. **José et al., [22]** reported that the biscuits of lemon revealed good accept in terms of smell, colour and taste properties, more than the minimum which of 3.0 on the scale used. Also, **Anis et al; [28]** reported that the sensorial characteristics of biscuit and replaced with10 g/100 g young corn flour in in relation to wheat flour content were more favorite than control samples. Biscuits are products obtained by the convenient kneading and baking of dough prepared with flour, starches, fermented or non-fermented starches, and other food ingredients **Šmídová & Rysová, [51]**. These products have been used as vehicles to add new ingredients to the diet that may be more nutritious or provide benefits to human health (**Egea et al., [52]; Goswami et al., [53]; Almeida et al., [54])**.

These authors showed that the new components were pleasantly seen in terms of color, taste and smell by the experiences panellists consulted. Also, these authors reported that the use of Arracacha flour in a ratio of 12% was a suitable composition in the production of high sensory admissibility biscuits, forming a food alternative.

Conclusions:

This study seen that the sensorial characteristics of biscuit with cauliflower stalk flour (CSF) replacement at 5% in relation to wheat flour content were same preferred and controls even though cauliflower (stalk, Leaves and flower) flour (CSF, CLF and CFF) biscuits slightly increased the hardness of biscuit and decreased the springiness and flexibility biscuits. Thus, the supplementary of cauliflower (stalk, Leaves and flower) flour in baked products components is adequate for baking process, since it is possibly be used as a part component for wheat flour substituted as well as being a functional component in composed bakery products because of its able to improve the nutritional quality without jeopardizing the palatability.

Interestingly, biscuit containing 5% cauliflower stalk flour received closely same score with the control of wheat flour biscuit score compared with other cauliflower (stalk, leaves and flower) flour biscuits compositions for most of the sensorial properties judged. In conclusion, cauliflower (stalk, leaves and flower) flour can be probable used as an alternative functional component for partial substituted of wheat flour in composed biscuit because of its able to improve the nutritional quality without ignoring sensorial palatability. The production of biscuits with cauliflower stalk flour (CSF) proved entirely feasible with regard to the acceptability of the product. Biscuits produced from cauliflower stalk flour (CSF), cauliflower flower flour (CFF) and cauliflower leaf flour (CLF) showed good acceptability and high fibre content. The biscuits prepared with cauliflower (stalk, leaves and flower) flour would be classified, as a biscuit products were ready for eat with high texture profile, physical properties and sensory evaluation. All attributes acceptability index reached above 70%.

Textural instruments give us the steady results for textural profile analysis. Textural measurement is a complicated process as a small mistake in the process may leads to a great loss. Consequently, at most care must be given. There are wide parameters that are to be looked during textural analysis of a product. The textural parameter also differs for different products. Therefore, correct parameters should be known for exact analysis. The texture of a product should be preserve from the processed product to reaching consumers mouth. Change in texture of a certain product suggest change of the constituents of a food product or the corrupted of a food product.

This research improved the reducing waste food, nevertheless whole plant tissues have been used resulting to the maximum take advantage of raw materials food. It is hence highly recommend to development biscuits production unit to improve biscuit functional characteristics.

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