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Effect of sweet potato flour and whey protein concentrate on dough for preparation of cookies

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Abstract
Textural properties of dough for cookies were studied by supplementing various proportion of sweet potato flour and whey protein concentrate (80%). The dough for cookies was subjected to texture profile analysis by using TA-XT2i (SMS) in order to determine hardness, cohesiveness, springiness, adhesiveness etc., hardness of prepared cookies determine by snap force and it is decreased significantly ($p< = 0.05$) from T_1 to T_5, as in control, hardness of dough is 0.8652±0.0165. The control dough had cohesiveness and adhesiveness values of 0.497±0.060 and -33.016±1.452. The cohesiveness of dough with 20% sweet potato flour and 20% of whey protein concentrate increased to 0.442±0.078 and then decreased with increasing percentage of whey protein concentrate. Hardness of the dough decreased with increasing of whey protein concentrate hardness of dough is highest in T_1 [(WF (60%): SPF (40%): WPC (0%)] and lowest in T_5 [(WF (60%): SPF (0%) WPC (40%)], gumminess and chewiness was decreased significantly from T_1 to T5, where as in control (T0) is 0.4300±0.0570 and 0.2137±0.0392 respectively.

Keywords: Texture profile, cookies, dough, hardness, cohesiveness, springiness, adhesiveness

1. Introduction
The bakery industry in India produces bread, biscuits, cakes, buns in lakhs of tones annually in which the share of biscuits is highest. The total production of biscuits in India is estimated to be around 30 lakhs metric tonne, the organized sector accounts for 65% and the unorganized sector accounts for 35% of the total industry volume. The penetration of biscuits in urban and rural market is 85% and 55% respectively (Divya, 2011) [3]. Biscuits industries are generally facing a problem of nutritional value as biscuits are low in protein quantity (6-7 percent) and deficient with essential amino acid lysine (Lauck, 1978; Singh *et al*., 1996) [13, 14].
Global Industry Analysts, Inc., (GIA), in a recently concluded off-the-shelf market research stated that the global baking industry is currently facing opportunities as well as challenges created by the economic crisis. Demand for bakery products have always been growing over th Cookies are ready to eat, convenient, inexpensive and one of the most popular and widely consumed processed food products in India. The cookies industry has been growing at an average rate of 6-7 percent during the past 5-6 years and this is expected to maintain in the coming years (Alagh, 1990) [1].
Sweet potato (*Ipomoea Batatas Lam)* is the seventh most important food crop in the world. It is grown in many tropical and subtropical regions. Among the world's major food crops, sweet potato produces the highest amount of edible energy per hectare per day (Horton and Fano, 1985). Sweet potato flour can serve as a source of energy and nutrients (carbohydrates, beta-carotene (provitamin A), minerals (Ca, P, Fe, and K)), and can add natural sweetness, color, flavor and dietary fiber to processed food products (Woolfe, 1992; Ulm, 1988) [5, 6].
Traditionally cookies are made from Refined Refined wheat flour and there is little record of rice being used in cookie type products. Small quantities of other cereal flours or starches can be added to give special flavors or structural properties.
Whey is a collective term referring to the serum of watery portion that separates from the curd during conventional cheese making (Chauhan & Chawla, 2011) [8]. Main proteins present in milk are whey protein and casein. It is rich in calcium, phosphorus, essential amino acids, and water-soluble vitamins, which makes whey a highly nutritious product (Davis, 2004) [9]. Whey can be incorporated advantageously into various food formulations, including cookies, breads, cake, crackers, pasta, confectionary products, ice creams, soups and gravies, frozen desserts beverages infant food formulations, and special dietetic food (Munaza, Prasad, & Gayas, 2012) [10].

Dough is the intermediate stage between flour and the bakery product. The rheological characteristics of the dough are very important, as they influence the machinability of the dough as well as the quality of the finished product (Faridi and Faubion, 1986) [11]. Thus, the present study was aimed to study the rheological characteristics of the dough with the effect of incorporation of sweet potato flour and WPC into the wheat based cookies.

2. Material and methods

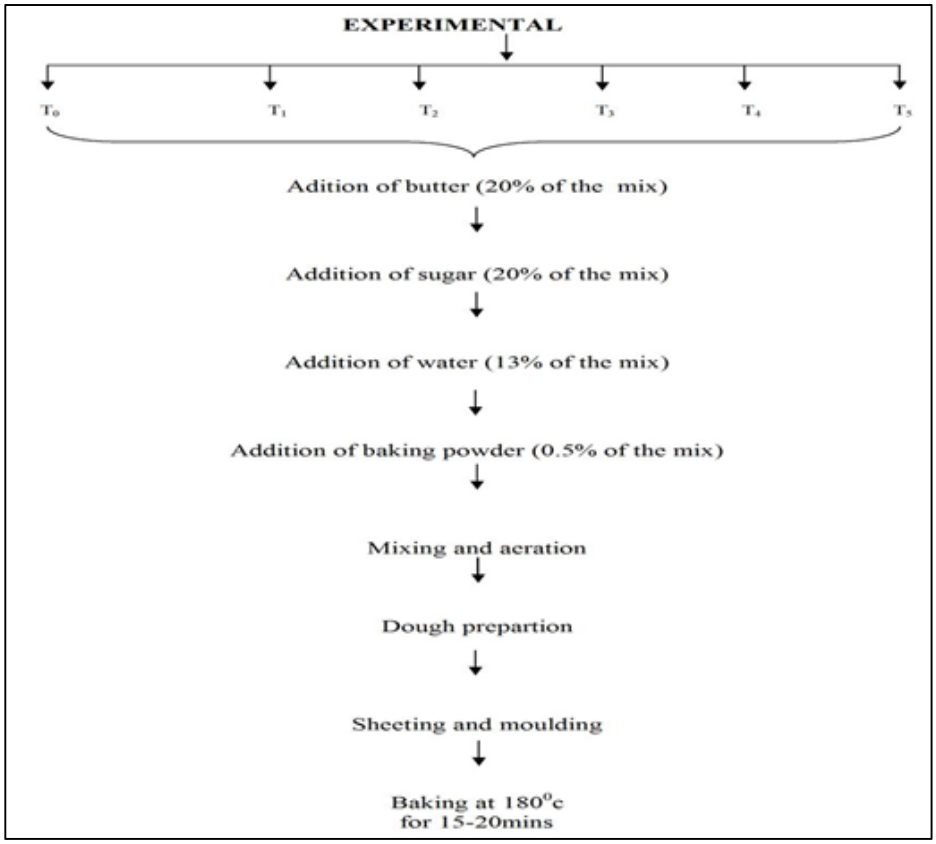
Sweet potatoes were procured locally from the field after harvesting. Roots were washed, trimmed and cured to make them free from soil and other foreign materials, rotting, insect damage and washed with common salt and made into slices, dried by using tray drier at 60°C for 6h and then Grinding, Sieving on 70 mesh. The prepared Sweet potato flour Packed in HDPE and stored for 6 months or more in sealed containers.

WPC were procured from Mahan proteins ltd., Delhi, India. Refined wheat flour, sugar, shortening (Amul Butter) were procured from local market of Allahabad (India) and kept at room temperature for further use. All chemicals used were of analytical grade.

2.1 Preparation of cookies dough

Cookie dough was made in a laboratory mixer. Fat and sugar was creamed in a mixer with a flat beater for 2 min at slow speed. Sodium chloride was added to the resulting cream, and mixed for 5 min at high speed to obtain a homogeneous mixture. Finally, flour containing various proportions of sweet potato flour, and whey protein concentrate (80%) which had been sieved twice with baking powder was added, and mixed for 3 min at medium speed. The dough was rested for 30 min before evaluation.

2.2 Preparation of cookies



Flow chart: Rheological characteristics of dough

2.3 Texture profile analysis

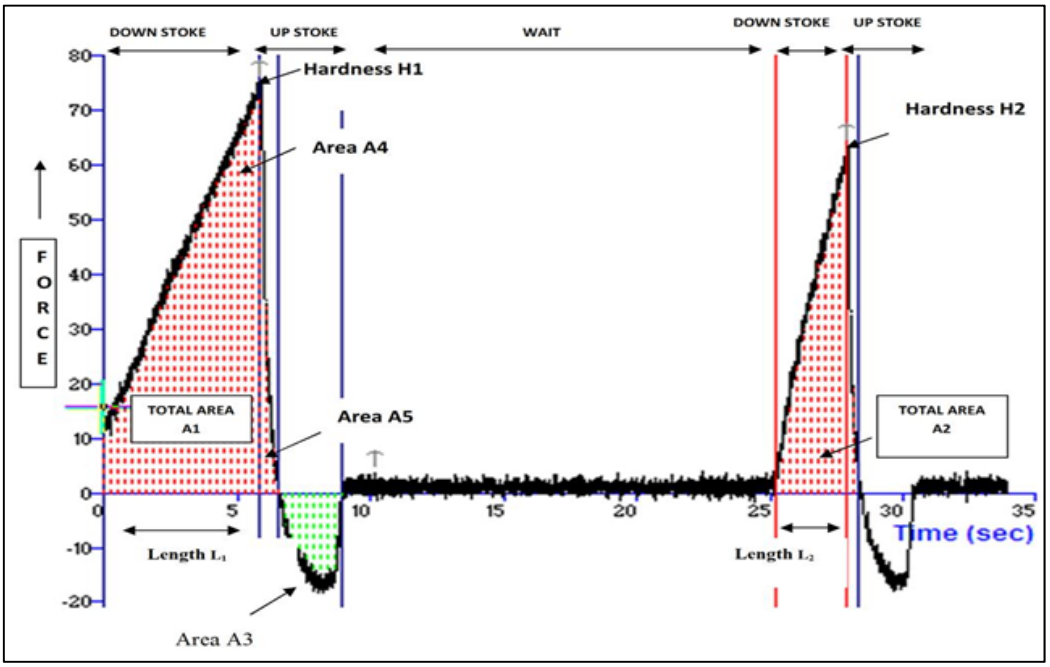
Texture profile analysis of the dough was carried out by texture analyzer (Model TA-XT2i, Stable Micro Systems, Haslemere, U.K.). under the following conditions: Probe (P75)/75mm ; Load cell, 50 kg; Pretest speed,3.0mm/s; Posttest speed, 10.0mm/s. Dough samples were obtained by sheeting with a rolling pin over a rectangular platform and frame of height 1.0 cm to give a sheet of 1.0 cm thickness. The sheeted dough was cut into a circular shape using cutters of 4.5 cm diameter. The cylindrical dough of 4.5 cm in diameter and 1.0 cm thickness was used for these studies. The real-time plots (Figure 1) were analyzed for the following: (1) dough hardness (N), the maximum resistance to the first compression peak (height of peak 1); (2) Springiness (mm) is Length 2/ Length 1; (3) Resilience (Area 5/ Area4) it is dimension less; (4) dough cohesiveness, the ratio of the areas of the two resistance peaks (Area 2/ Area 1) it is dimension less; (5) dough Adhesiveness (N.mm), the area of the first adhesion peak; (6) Gumminess (N) is the product of hardness and cohesiveness [H1 X (A2/A1)]. (7) Chewiness (N.mm) is the product of hardness, cohesiveness and Springiness [H1 X (A2/A1) X (L2/L1)]

Hardness of the baked cookies was measured using with a sharp blade-cutting probe. Pre-test, test, and post-test speeds were 1.5, 2, and 10 mm/s, respectively. Hardness, a maximum peak force, was measured with more than six cookies for each sample. The peak force to snap the cookies was reported as fracture force in N.

Table 1: Rheological characteristics of the dough

Treatments	Hardness(N)	Springiness mm	Cohesiveness	Resilience	Adhesiveness (N.mm)	Gumminess (N)	Chewiness (N.mm)
T0	0.8652±0.0165	0.6124±0.031	0.497±0.060	0.072±0.008	-33.016±1.452	0.4300±0.0570	0.2137±0.0392
T1	1.5116±0.0755	0.5626±0.063	1.337±0.146	0.073±0.011	-45.323±2.189	2.0210±0.2990	2.7021±0.3118
T2	1.4880±0.0618	0.5696±0.087	0.496±0.070	0.077±0.007	-32.946±0.730	0.7380±0.0676	0.3661±0.0557
T3	1.0536±0.0394	0.6122±0.090	0.442±0.078	0.125±0.021	-28.093±1.375	0.4657±0.1497	0.2058±0.1284
T4	0.7367±0.0189	0.4418±0.075	0.433±0.069	0.110±0.031	-28.401±0.686	0.3190±0.0542	0.1381±0.0476
T5	0.3490±0.0226	0.4096±0.053	0.390±0.049	0.074±0.005	-14.282±1.109	0.1361±0.0125	0.0531±0.0081

All values are represented in MEAN ± S.ED



Hardness: H1;
Springiness: L2/L1;
Resilience A5/A4;
Cohesiveness: A2/A1;
Gumminess: H1 X (A2/A1);
Chewiness: H1 X (A2/A1) X (L2/L1);
Adhesiveness: A3

Fig 1: The real-time plot for dough

3. Results and discussion

3.1 Texture profile analysis

The Rheological characteristics of the dough made from different proportion of sweet potato flour and whey protein concentrate (80%) are given in Table1 and figure 1 Varying the sweet potato flour and whey protein concentrate (80%) changed the textural characteristics of dough significantly. The hardness decreased significantly from 1.5116± 0.0755(N) (T_1 = WF (60%): SPF (40%): WPC (0%)) to 0.3490 ±0.0226 (T5 WF (60%): SPF (0%) WPC (40%)) where as in control T_0 (WF (100%): SPF (0%): WPC (0%)) hardness is 0.8652±0.0165.A similar trend was observed for the incorporating sweet potato flour to wheat flour to the cookies dough studied by (Singh, *et al*., 2008) [12].

Adhesiveness, of dough's increased significantly (p< = 0.05) from T_1 (-45.323±2.189) to T_5 (-14.282±1.109) where as in control it is -33.016±1.452. The cohesiveness decreased significantly (p< = 0.05) from 1.337±0.146 (T1) to 0.390±0.049 (T5) where as in control it is 0.497±0.060

Springiness of dough is in following order control T_0 (0.6124±0.031) > T_3 (0.6122±0.090) > T_2 (0.5696±0.087) > T_1 (0.5626±0.063) T_4 > (0.4418±0.075) > T_5 (0.4096±0.053). There is a significant increase (p< = 0.05) from T_1 to T_3 and springiness decreased from T_3 to T_5, these increase and decrease effect is due to the variation in proportions of sweet potato flour and whey protein concentrate (80%). Same trend followed in resilience of dough, the values are as follows: T_0 (0.072±0.008), T_1 (0.073±0.011), T_2 (0.077±0.007), T_3 (0.125±0.021), T_4 0.110±0.031, T_5 (0.074±0.005). Resilience is more in T_3 (0.125±0.021) followed by T_4 (0.110±0.031), least in control T_0 (0.072±0.008).

Dough Gumminess was decreased significantly from T_1, 2.0210±0.2990 to T_5 0.1361±0.0125 Where as in T_0 (control) gumminess is 0.4300±0.0570. Chewiness of dough is more in T_1 (2.7021±0.3118) followed by T_2 0.3661±0.0557, T_3 (0.2058±0.1284), T_0 (0.2137±0.0392), T_4 (0.1381±0.0476), T_5 (0.0531±0.0081). There is a significant decrease (p< = 0.05) of Chewiness from T_1 to T_5, similar results was found by Asghar *et al.,* (2009) [2] studied on the effect of modified whey protein concentrates on instrumental texture analysis of frozen dough. He found that there is a significant (p< = 0.05) decrease in value of gumminess with increase in proportion of whey protein concentrates.

3.2 Hardness of cookies

The textural property is one of the important parameter to evaluate the quality of cookies. Hardness of cookies was significantly affected by sweet potato flour and whey protein concentrate (80%), it is shown in the Table 2. The study shows that the force required for breaking the cookies. It is decreased significantly ($p< = 0.05$) from T_1 to T_3 as the level of sweet potato flour decreased and whey protein concentrate increases. Similar result was reported by Chung *et al*. (2014) [7] for cookies prepared with incorporation of brown rice and germinated brown rice. The decrease in hardness could be attributed to the structural degradation of starch and protein induced by germination. The degradation of macromolecules contributed to the formation of weaker matrix in cookie, resulting in the softer texture. Hardness of cookies increased significantly ($p< = 0.05$) from T3 to T5 as the whey protein concentrate percentage was increased.

Table 2: Hardness of cookies

Treatments	Hardness(N)
T0 (WF (100%): SPF (0%): WPC (0%))	100.012±2.579
T1 (WF (60%): SPF (40%): WPC (0%))	161.809±13.110
T2 (WF (60%): SPF (30%): WPC (10%))	150.608±6.178
T3 (WF (60%): SPF (20%): WPC (20%))	130.526±6.029
T4 (WF (60%): SPF (10%): WPC (30%))	184.541±8.509
T5 (WF (60%): SPF (0%) WPC (40%))	244.392±22.083

4. Conclusion

The instrumental texture analysis study of dough for cookies prepared with the addition of sweet potato flour and whey protein concentrate (80%) revealed that the sweet potato flour is a good source of fiber, and whey protein is rich in protein content. Characteristics of dough play a major role in cookies preparation. T_3 which contains WF (60%): SPF (20%): WPC (20%) was found to be most suitable for the production of cookies, even though it has equal portions of fiber and protein. Characteristics of the cookies were significantly influenced by the addition of both Sweet potato flour and whey protein concentrate (80%). So, the use of sweet potato flour and whey protein in cookie was effective for technological and nutritional advantages of cookies

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