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Research Paper

Development of Herbal Cookies from Finger Millet Malt and *Aloe vera* Powder

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ABSTRACT

In this paper effect of incorporation of *Aloe vera* powder (0.5, 1.0, 1.5, and 2.0 %) and baking temperature i.e. 160˚C, 170˚C and 180˚C on the various physico-chemical quality characteristics and sensory score was evaluated. The cookies were prepared by replacing the finger millet malt with *Aloe vera* powder. The various quality parameters like moisture, protein, fat, ash, fiber, carbohydrate, hardness, browning index and baking time with the sensory attributes i.e. colour, flavor, texture and taste of the finger millet malt and *Aloe vera* powder cookies was evaluated. The superimposed contour plots resulted the best quality characteristics of moisture 3%, protein 2.4%, fat 40.5%, ash 2.8%, fiber 2.4%, hardness 14.2 g, browning index 12.4 and baking time 72 min at p≤0.05 respectively. The best sensory scores were colour 7.41, flavor 7.05, texture 7.64 and taste 8.18 respectively. The optimum product quality arises at *Aloe vera* powder incorporation 1.5 % and baking temperature at 170˚C.

Keywords: Finger millet malt and *Aloe vera* powder cookies, quality parameter of cookies, sensory analysis

Baking is a complex process in which chemical and physical changes take place simultaneously. Dough pieces chiefly undergo changes in structure, taste, colour, and size during baking (Gokmen *et al.* 2008). The bakery industry is one of the largest organized food industries all over the world and in particular biscuits and cookies are one of the most popular products because of their convenience, ready to eat nature, and long shelf life (Sindhuja *et al.* 2005).

Cookies are small, flat dessert treats, commonly formed into a circular shape. They constitute an important component of the diet (Mishra *et al*. 2012). Cookies are one of the best known quick snack products (Farheena *et al.* 2015). Cookies hold an important position in snack food industry due to variety of taste, nutrition, crispiness and digestibility (Kang *et al.* 2008). Olaoye *et al.* (2007) described cookies as nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven. They are popular examples of bakery product of ready-to-eat snack that possess several attractive features including wide consumption, more convenient with long shelf-life and have the ability to serve as vehicles for important nutrient (Ajibola *et al.* 2015).

Cookies and other bakery products have now become loved fast food products for every age-group, because they are easy to prepare, tasty to eat, cholesterol-free, containing digestive and dietary principles of

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vital importance and reasonably cheap (Farheena *et al.* 2015). The main ingredients of cookies are wheat flour, fat (margarine), sugar and water, while other ingredients such as milk, salt, aerating agent, emulsifier, flavor and colour can be included. They can also be enriched or fortified with other ingredients in order to meet specific nutritional or therapeutic needs of consumers (Ajibola *et al.* 2015). Flour used in making cookies is basically from wheat or composite flour which forms the basic ingredients of bakery products including bread, rolls, cakes, cookies and other bakery products (Giwa and Ikujenlola, 2010).

Finger millet (*Eleusine coracana*) is popular in India in various names such as *ragi*,*nachani* or *nagli* is one of the important millet in India. The world production of millet grains in year 2013 was 7, 62,712 metric ton and India was the top producer with an annual output of 3, 34,500 tons contributing 43.85% (FAO, 2013). Finger millet ranks fourth in importance among millets after sorghum, pearl millet and foxtail millet (Upadhyaya *et al*. 2007). It is widely cultivated in Africa and South Asia under varies agro-climatic conditions and is estimated that some of 10% of the world's 30 million tons of millets produced is finger millet (Dida *et al.* 2008).

The nutraceutical importance of finger millet lies in its high content of calcium (0.38%), protein (6%-13%), dietary fiber (18%), carbohydrates (65-75%), minerals (2.5-3.5%), phytates (0.48%), tannins (0.61%), phenolic compound (0.3-3%), and trypsin inhibitory factors and is recognized for its health beneficial effects, such as anti-diabetic, antitumrogenic and antiulcer, anti-inflammatory, atherosclerogenic effects, antioxidant and antimicrobial properties.

The simple traditional household technologies have been used to process in order to improve nutritional quality as germination, fermentation, roasting and cooking. As far as it is concerned germination when grains are hydrated in ambient conditions endogenous enzyme start to modify the grain constituents in particular changes to soluble sugars, protein and activities in enzyme (Nadeem *et al*. 2010).

Malting is a simple bio-technological technique to bring about sufficient increase in enzyme activities and causes predigestion of carbohydrate and protein (Ghavidel *et al*. 2011). Malted seeds of finger millet after 24 hours of germination have significantly higher level of free amino acid and reducing sugar content when compared to raw seeds (Banusha *et al*. 2013). Drying process in malting stops the germination process further and presents enzymes inactive form along with high bio-accessibility of nutrients in the end product (Sharma and Chopra, 2015).

Aloe Barbadensis miller, commonly referred as *Aloe vera*, is one of more than 400 species of Aloe belonging to family Liliaceae that has originated in South Africa. But have been indigenous to dry subtropical and tropical climates, including Southern USA (Reynolds and Dweek, 1999). In India, only 4 species (*Aloe barbadensis, Aloe forbessii, Aloe inermis, Aloe ferox*) are reported to occur and of these *Aloe barbadensis* is the most widely distributed species (Nandal *et al*. 2012).

The plant is commercially cultivated in Aruba, Bonaire, Haiti, India, South Africa, the United States of America and Venezuela (Yeh *et al*. 2003) while the finest quality of Aloe is grown in desert of Southern California (Sahu, 2013). In India, it is found in Rajasthan, Andhra Pradesh, Gujarat, Maharashtra and Tamil Nadu (Surjushe *et al.* 2008). It is grown in India on an area of 784 ha (6.47%) with a production of 7.81% and productivity 9.10 Million tons (Anonymous, 2013). Genus Aloe is a perennial succulent herb have grown in temperate and subtropical part of the word (Joseph *et al.* 2010). *Aloe vera* is well recognized as a source of the valuable material in functional foods, cosmetics, and medicines (Kawai and others 1993; Eshun and He, 2004; Rodriguez *et al*. 2010).

Physical and biochemical properties of *Aloe vera* gel has been well characterized (Femenia *et al.* 2013; Femenia *et al*. 1999) and extensively investigated (Ni *et al.* 2004; Rodriguez-Gonzalez *et al.* 2011; Sharrif and Sandeep, 2001). It contains a number of nutrientssuch as vitamins, fatty acids, amino acids, sugars, minerals,enzymes therefore dried powder can be used in formulationsas a functional ingredient

for health benefits. Aloe leaf powder, which contains antioxidants, dietary fibre, iron, etc., may find its usage in number of ayurvedic medicines (Gulia *et al.* 2010). *Aloe vera* powder which contains antioxidants, dietary fiber, iron etc may find its usage in number of Ayurvedic medicines.

Wheat flour is the principal component of nearly all biscuits (Manley, 2000). This holds a unique position due to its ability to form dough (Nadeem *et al*. 2010). Wheat flour is deficient in certain essential amino acids, specially, lysine. The cookies using the finger millet malt and *Aloe vera* powder will not only help to enrich the nutritional value to the cookies but also imparts the herbal component of various nutrients. This may help to various consumers like diabetics, hipertension, lowerly the blood pressure. There fore an attempt has been made to develop the cookies of wheat flour incorporated with finger millet malt and the *Aloe vera* powder.

MATERIALS AND METHODS

Raw materials of Finger millet (*Eleusine coracana*) and wheat flour were procured from local market, Roha dist- Raigad and *Aloe vera* plant leaves were procured from the farmers' field at Sangli. The study was carried out in the Department of Post Harvest Engineering, post Graduate Institute of Post Harvest Management, Killa-Roha.

Development of Finger Millet malt

The finger millet malt was prepared as per the procedure Swami *et al.* 2013. Finger millet grain of *Dapoli-1* variety was brought from the local market. The grain were cleaned and made it free from dirt, dust and small stores. 1000 g of clean finger millet grains were soaked in the tap water 1:3 for 5h at normal atmospheric temperature (31± 1˚C). The water was drained out and the soaked grains were placed in a muslin cloth and allowed to germinate for 24 hours. The germinated sample was removed from moist cloth after 24 h for germination and placed in a tray dryer at 45˚C for 6 hrs to 5.155 ±2% (db) moisture content. After the drying was complete the vegetative growth portion were removed by gentle brushing by hand. The devegetative seeds were grounded to the flour by using the food processor (M/s: Aditi Associates, Mumbai; Model: ATD-124) having power requirement 5 kW.

Preparation of *Aloe vera* powder

Aloe vera leaves were washed to remove dirt; dust using tap water, the surface moisture was removed. The *Aloe vera* leaves were sliced in to small pieces of 1 cm thickness. The slices were placed in the Stainless Steel tray in a single layer at 45˚C dried from 4684.68 up to 7.38804% (db) for 34 h. The drying was carried out in a tray dryer (M/s: Aditi Associate Mumbai; Model: ATD-124) having capacity 5 kW.

Process for preparation of finger millet malt-*Aloe vera* powder and wheat flour based cookies

Fig. 1 shows the process technology for preparation of finger millet malt-*Aloe vera* powder and wheat flour based cookies. 100g of flour i.e. (finger millet malt: *Aloe vera* powder: wheat flour as per the various treatments listed in treatments T_1 to T_5 in Table 1 was taken in a tray, and 50g of sugar and 50g of vegetable oil was added to it. The mixture was added with 0.5 (g) of baking powder. The mixture was vigorously mixed for dough formation. The dough was sheeted thickness 6.6 mm in a plate and cut into the uniform size of cookies (round shape d = 52 mm). The cookies were placed in the oven (Make: M/s L. G. Electronics India Pvt. Ltd., India. Model: MC-8083MLR) and baked at 160˚C, 170˚C and 180˚C up to the colour of cookies changes into brown. The cookies were prepared for each treatment T_1, T_2, T_3, T_4 and T_5 respectively. The three replication for each experiment was carried out.

Evaluation of Quality parameters for cookies

1. Moisture

The initial moisture content of cookies was determined by using hot air oven method (AOAC, 2000). The 5 g cookies sample taken in the moisture box. The moisture box was kept in hot air oven at 110˚C±1 for 24 h. the final weight of cookies sample

Table 1: Treatment levels for finger millet malt and *Aloe vera* powder cookies sample

Treatments	Composition of Flour (%)			Other Ingredients		
	Finger millet malt	*Aloe vera* powder	Wheat flour	Sugar (%)	Fat (%)	Baking powder (%)
T_1	00.0	00.0	100.0	50.0	50.0	0.5
T_2	49.5	0.5	50.0	50.0	50.0	0.5
T_3	49.0	1.0	50.0	50.0	50.0	0.5
T_4	48.5	1.5	50.0	50.0	50.0	0.5
T_5	48.0	2.0	50.0	50.0	50.0	0.5

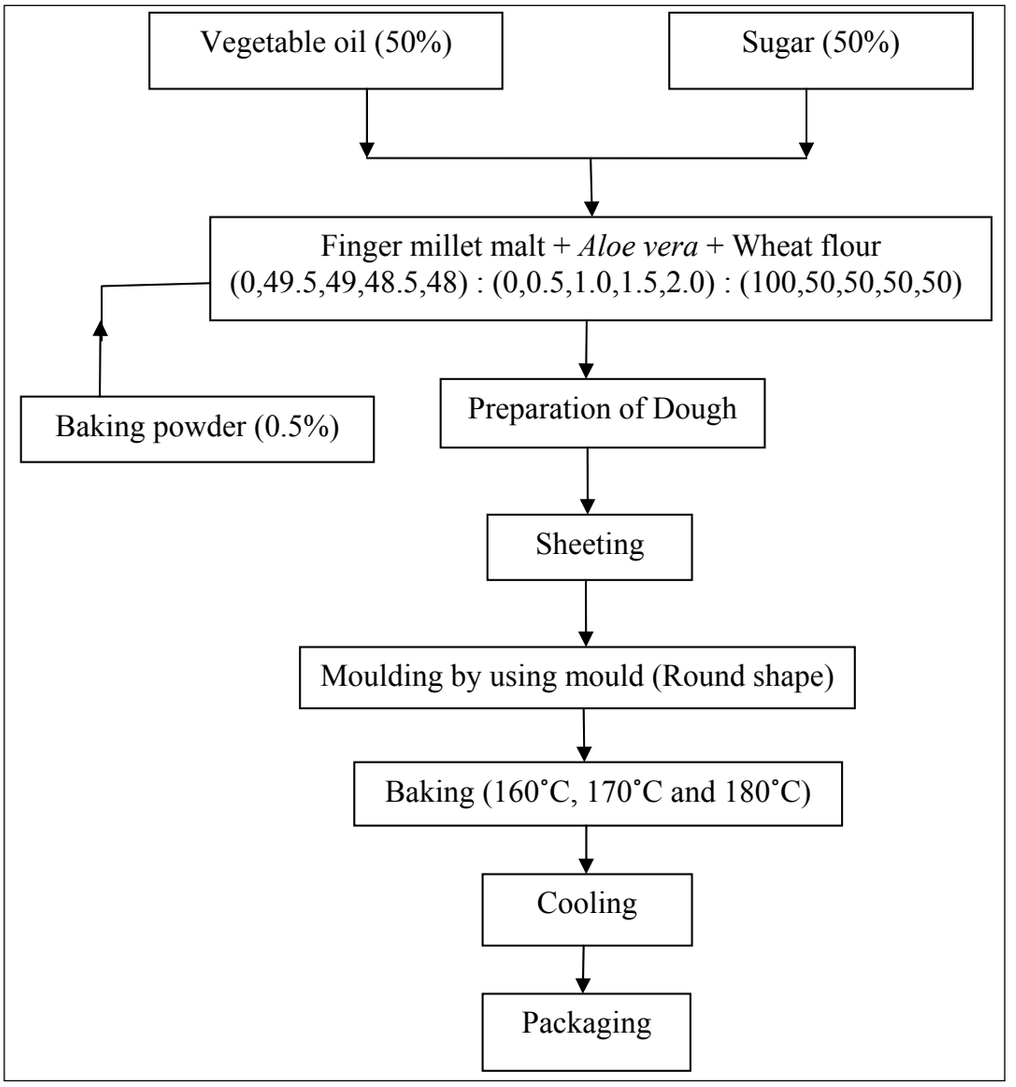

Fig. 1: Process technology for herbal cookies of finger millet malt and *Aloe vera* powder

after 24 h were recorded. The moisture content of the cookies was replicated 3 times. The average value of moisture content is reported. The moisture content was calculated by using following formula (1);

$$\text{Moisture content (\% db)} = \frac{W_2 - W_1}{W_3 - W_1} \times 100 \quad \ldots(1)$$

Where,

W_1 = Weight of moisture box, g

W_2 = Weight of moisture box + sample g

W_3 = Weight of moisture box + oven dried sample, g

2. Protein

Crude protein of the cookies was determined using the Kjedahl method according to AOAC (1990). One gram of the cookies sample was taken into the digestion flask. Kjedahl catalyst (Selenium tablets) was added to the sample. Twenty milliliter of concentrated sulphuric acid was added to the sample and fixed to the digester flask for eight hours until a clear solution was obtained. The cooled digester mass was transferred into one hundred mils volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for ten minutes after boiling. Twenty milliliter of 4% boric acid was pipetted into conical flask. Five drops of methyl red was added to the flask as indicator and the sample was diluted with seventy five milliliter distilled water. Ten milliliter of the digest was made alkaline with twenty miles of NaOH (20%) and distilled. The steam exit of the distillatory was closed and the change of color of boric acid solution to green was timed. The mixture was distilled for fifteen minutes. The filtrate was then titrated against 0.1 N HCL. The experiments were repeated three times and average reading was reported.

$$\text{\% N} = \frac{(\text{Sample titre} - \text{Blank titre}) \times N\ HCL \times 1.4 \times 100}{\text{Weight of sample}} \times 100 \quad \ldots(2)$$

3. Fat

Fat content of cookies was determined by soxhlet fat extraction system (AOAC, 2010) by Soxhlet apparatus (Make: Elico, Hyderabad). In this method, initially weight of empty flask was weighted. 2 g cookies sample were wrapped in filter paper. The cookies sample with filter paper was kept in siphoning tube and condenser was fixed above it and siphoned for 9-12 times with the petroleum ether in soxhlet apparatus. After removing assembly, evaporation of petroleum ether was allowed by heating round bottom flask. Residue remained at the bottom of the flask and was reweighted with flask. The quantity of residue was determined as fat content of cookies. The experiment was replicated for 3 times. The average value of fat content is reported. The fat content was calculated by using following formula (3);

$$\text{\% Fat content} = \frac{\text{Final wt.} - \text{Initial wt}}{\text{Wt.of sample}} \times 100 \quad \ldots(3)$$

4. Ash

Ash content of cookies was determined by using muffle furnace. 5 g of cookies sample was taken in a crucible. Weight of crucible and sample was recorded kept in muffle furnace at 650°C for 4-5 h till constant weight was achieved. It was observed for their constant readings. The crucible was cooled in desiccators and final weight of ash and crucible was recorded. The experiment was replicated for 3 times. The average value of ash content is reported. The ash content was calculated by using following formula (4);

$$\text{Ash} = \frac{W_2 - W}{W_1 - W} \times 100 \quad \ldots(4)$$

Where,

W = weight of crucible, g;

W_1 = weight of crucible and sample, g; and

W_2 = weight of crucible with ash, g

5. Fiber

The fiber content cookies were determined by the fat free sample available in filter paper from fat extraction method (Ranganna, 1986). The filter paper

and fat free residue was kept in the oven for 105°C for 5-6 hours. Around 2 g sample from oven was taken into 600 ml beaker and boiled, 200 ml 1.25 % H_2SO_4 was added to it. The beaker containing solution was placed on hot plate for 30 min. After heating residue from beaker was filtered through filter paper and rinsed beaker with 50 to 75 ml boiling water for three times. The filtered residue from filter paper was dried by convective hot air drying for 2-3 h at 130°C. The dried residue from convective hot air dryer was transferred to 600 ml beaker and boiled, 200 ml 1.25 % NaOH was added to it and boiled for 30 more minutes on hot plate. After heating residue from beaker was filtered through filter paper and rinsed beaker with 50 to 75 ml boiling water for three times. The filtered residue from filter paper was dried by convective hot air drying at 130°C for 2h. The dried residue was weighted after cooling and weight was noted. The weighed residue was transferred to crucible in hot air oven and ignited for 30 minutes at 600°C and reweighed after cooled in dessicator and weight was recorded. The experiment was replicated for 3 times. The average value of crude fiber content is reported. The crude fiber content was calculated by using following formula (5);

$$\% \text{ Fiber} = \frac{\text{Weight of residue with crucible} - \text{Weight of ash with crucible}}{\text{Weight of sample}} \times 100 \quad \ldots(5)$$

6. Carbohydrates

Carbohydrate content of the cookies samples was determined by subtracting the total sum of protein, fiber, ash and fat from the total dry matter (Vengaiah *et al*. 2013). The carbohydrate was calculated by using following formula (6);

$$\% \text{ Carbohydr} = 100 - (\% \text{ protein} + \% \text{ fat} + \% \text{ fiber} + \% \text{ ash} + \% \text{ moisture content}) \quad \ldots(6)$$

7. Hardness

The Hardness of cookies measured with texture analyzer. The texture analyzer (Make: M/s Perten Instrument, USA. Model- TexVol TVT-300 XP). The above mentioned cookies of 4 mm were exposed to compression test with probe no-6, size 0.5 mm and pre-test speed was 60 mm/s, compression depth was 70 % and trigger load was 5 g for cookies. The equipment gives the value of hardness.

8. Browning index

Colour of cookies sample was measured by using Konica Minolta colour Reader. (Make: Minolta Camera Co. Ltd. Japan Model: (R-10). The colour of the Samples was measured in dark room. The cookies sample was placed on white surface and placing colour reader on the cookies sample in a Petri dish and the colour was measured in L, a, b were reported. Where L value indicates degree of lightness or darkness, 'a' value indicates redness or greenness and 'b' value indicates the yellowness or blueness.

This index indicates the brown color purity which can be calculated in this way (Perez-Gago *et al*. 2006).

$$BI = \frac{100 \times (\chi - 0.31)}{0.172} \quad \ldots(7)$$

$$\chi = \frac{a * 1.75L *}{5.645L * a * -3.012b *} \quad \ldots(8)$$

Optimum product quality

The finger millet malt and *Aloe vera* powder cookies should have moderate moisture content, more protein content, moderate fat content, more ash content, moderate fiber content, moderate hardness, less browning index and less baking time. Based on these desirable attribute, the contour plot of each responses were superimposed for the optimum product quality. Bases on the desirable common attributes the optimum zone of desirable properties has been obtained.

Sensory analysis

The sensory attribute of finger millet malt and *Aloe vera* powder cookies was evaluated with semi-trained panelists. The panelists were trained for the product testing and were familiar with product sensory evaluation. Finger millet malt and *Aloe vera* powder cookies were placed in plates. The cookies prepared

from all the treatments were coded from A to M. There were around 13 different samples out of which 12 were from the different treatments and 1 treatment was of control. Which were made from finger millet malt: *Aloe vera* powder: wheat flour for evaluation of sensory parameters i. e. colour, flavor, texture and taste. 9 Scales for colour, 9 scales for flavor attribute9 scales for texture attribute and 9 scales for taste. The attribute were summed up for total score 36 for each panelist for each treatment. The data were analyzed statistically for the significant of each attribute by ANOVA.

Correlation between the optimum product quality and the sensory attributes

The optimum product quality based on the desirable quality attributes i.e. moderate moisture content, more protein content, moderate fat content, more ash content, moderate fiber content, moderate hardness, less browning index and less baking time with optimum zone was compared with the best sensory attribute of the best treatment judged by the sensory panelist. The best treatment was decided based on the correlated the optimum product quality with the subjective quality evaluation.

RESULTS AND DISCUSSION

Preparation of Finger millet malt and *Aloe vera* powder

Finger millet malt flour and *Aloe vera* powder prepared by convective hot air drying method to produce good quality of the flour and *Aloe vera* powder can be used as partial replacement for Finger millet malt, for the preparation of cookies.

Proximate composition of *Aloe vera* powder, Finger millet malt, wheat flour and their blends.

Table 2 (a) shows the (%) moisture content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Moisture content of *Aloe vera* powder was 4.88±0.02 per cent, finger millet malt was 5.6±0.10 per cent and wheat flour was 9.36±0.03 per cent. Moisture content of (FM:AVP:W) blended flour decreased from 9.17±0.01 to 9.13±0.01 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The decrease in moisture was significant at p≤0.01. A similar result was observed by Haque *et al.* (2014) noticed that 6.75 per cent moisture content in *Aloe vera* powder. Olua *et al.,* (2015) reported that the moisture content of the cashew apple powder (6.73) per cent was lower than 7.05 per cent reported by Ogunhobi and Ogunwolu (2010). James *et al.* (2015) noticed that 4.26±2.00 per cent moisture in millet flour. Olua *et al*. (2015) reported that moisture content in whole wheat flour was 6.60±0.14 per cent.

Table 2 (b) shows the (%) protein content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Protein content of *Aloe vera* powder was 7.10±0.03 per cent. Finger millet malt was 6.43±0.26 per cent and protein content of wheat flour was 10.16±0.05 per cent. Protein content of (FM:AVP:W) blended flour increased from 5.15±0.05 to 9.00±0.47 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The increases in protein was significant at p≤0.01. Gulia *et al.* (2010) reported that protein content of *Aloe vera* powder was 4.64±0.10, 4.62±0.10, 4.62±0.10 and 4.65±0.10 at 50, 60, 70, 80˚C it decreases with increase in temperature from 50 to 80˚C. Similar results was observed by Ahmed *et al.,* (2013) who reported that the protein content of *Aloe vera* powder was 6.86±0.06 per cent. The results are in similar line with the reported value of the protein 4.8 per cent (Gautam and Awasthi, 2007).The malting had an increasing effect on the protein content of finger millet flour. The identical result was reported by Lande *et al.* (2017) who recorded 6.42 per cent protein content in finger millet malt.

Table 2 (c) shows the (%) fat content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Fat content of *Aloe vera* powder was 2.02±0.12 per cent, finger millet malt was 1.18±0.05 per cent and fat content of wheat flour was 2.67±1.15 per cent. Fat content of (FM:AVP:W) blended flour increased from 13.20±0.20 to 14.73±0.12 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The increases in fat were significant at p≤0.01. Gulia *et al.* (2010) who reported that the fat

Table 2: Proximate chemical composition of *Aloe vera* powder, Finger millet malt, wheat flour and their blends

Sample	(a) Moisture	(b) Protein	(c) Fat	(d) Ash	(e) Fiber	(f) Carbohydrates
Aloe vera powder	4.88±0.02	7.10±0.03	2.02±0.12	16.33±0.29	14.98±1.38	54.68±1.71
Finger millet malt	5.6 ± 0.10	6.43 ± 0.26	1.18 ± 0.05	1.5 ± 0.03	3.75 ± 0.01	81.57 ± 0.42
Wheat flour	9.36±0.03	10.16±0.05	2.67±1.15	2.15±0.13	1.81±0.27	73.85±1.50
(FM:AVP:W) 49.5:0.5:50	9.17±0.01	5.15±0.05	13.20±0.20	2.05±0.01	1.94±0.08	68.36±0.10
(FM:AVP:W) 49:1.0:50	9.37±0.01	9.60±0.07	13.87±0.12	2.65±0.28	1.60±0.05	62.92±0.37
(FM:AVP:W) 48.5:1.5:50	9.19±0.01	7.01±0.07	14.67±1.15	2.77±0.08	1.12±0.57	64.51±1.51
(FM:AVP:W) 48:2.0:50	9.13±0.01	9.00±0.47	14.73±0.12	2.93±0.08	2.69±0.15	61.48±0.53
SEm±	0.02	0.11	0.36	0.10	0.33	0.62
$CD_{at1\%}$	0.09	0.45	1.52	0.40	1.40	2.61

FM = Finger millet malt, AVP = Aloe vera powder and W = Wheat flour

content of *Aloe vera* powder ranged was 2.05±0.05, 2.05±0.08, 2.1±0.10 and 2.12±0.11 per cent at 50, 60, 70 and 80˚C respectively. Ahmed *et al.,* (2013) reported that 2.91±0.09 per cent fat content in *Aloe vera* powder. A similar result was observed by Prakash and Chopra, (2016) who reported that the fat content in finger millet malt was 1.15±0.14 per cent. Ritika *et al*. (2016) reported that fat content in wheat flour was 1.78±0.23 per cent.

Table 2 (d) shows the (%) ash content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Ash content of *Aloe vera* powder was 16.33±0.29 per cent, finger millet malt was 1.5±0.03 per cent and ash content of wheat flour was 2.15±0.13 per cent. Ash content of (FM:AVP:W) blended flour increased from 2.05±0.01 to 2.93±0.08 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The increases in ash were significant at p≤0.01. Gulia *et al.* (2010) reported that ash content in *Aloe vera* powder was 15.48±0.02, 15.48±0.1, 15.49±0.05 and 15.50±0.05 at 50, 60, 70 and 80˚C respectively. Gautam and Awasthi (2007) also reported 14 per cent ash content in the whole leaf *Aloe vera* powder samples obtained after try drying at 50˚C. Similar results was observed by Prakash and Chopra, (2016) who reported that the ash content in finger millet malt was 1.88±0.16 per cent. Olua *et al*. (2015) reported that 1.99±0.01 per cent ash content in whole wheat flour.

Table 2 (e) shows the (%) fiber content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Fiber content of *Aloe vera* powder was 14.98±1.38 per cent, finger millet malt was 3.75±0.01 per cent and fiber content of wheat flour was 1.81±0.27 per cent. Fiber content of (FM:AVP:W) blended flour increased from 1.94±0.08 to 2.69±0.15 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The increases in fiber were significant at p≤0.01. Gulia *et al.,* (2010) reported that fiber content in *Aloe vera* powder ranged was 17.86±0.1 to 17.92±0.07 at 50˚C to 80˚C. A similar result was observed by Lande *et al.* (2017) who reported that the fiber content of finger millet malt was 3.36 per cent. Blessing *et al.* (2014) reported that 11.37±0.06 per cent fiber in wheat flour.

Table 2 (f) shows the (%) carbohydrate content for *Aloe vera* powder: Finger millet malt: wheat flour and their blends. Carbohydrate content of *Aloe vera* powder was 54.68±1.71 per cent, finger millet malt was 81.57±0.42 per cent and carbohydrate content of wheat flour was 73.85±1.50 per cent. Carbohydrate content of (FM:AVP:W) blended flour decreases from 68.36±0.10 to 61.48±0.53 per cent, as the percentage of *Aloe vera* powder in the blends increased from 0.5 to 2.0 per cent. The decreases in carbohydrate were significant at p≤0.01. Haque *et al.* (2014) reported that 56.27 per cent carbohydrate content in *Aloe vera* powder.

Evaluation of quality parameter of finger millet malt and *Aloe vera* powder cookies

Fig. 1 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the Moisture content (%) Finger millet: *Aloe vera*: Wheat flour cookies. The Moisture content for all the treatments were in the range of 2.09-3.66%. As the *Aloe vera* (%) incorporation increases from 0.5 to 2.0%, the moisture content decreases. Similarly as the baking temperature increases from 160˚C to 180˚C, the moisture contentdecreases. As both the *Aloe vera* powder (%) and Baking temperature (˚C) increase the moisture content decreases. This can be seen from contour plot Fig. 1 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the Moisture content can be seen by the second order polynomial equation (1). The equation is well fitted with $r^2 = 0.817$ and $MSE = 1.584$

$$M_C = -5.69013 \times 10^1 + 0.73725B_T - 0.0022375B_T^2 - 0.221A_v - 0.0051A_v B_T + 0.36A_v^2 \quad \ldots(1)$$

Where,

M_c = Moisture content, (%db)

B_T = Baking temperature, (˚C) and

A_v = *Aloe vera* powder, (%)

Table 3 (a) shows the ANOVA for the moisture content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant.

Similar kinds of result have been reported Kumar *et al*. (2015) the moisture content in wheat flour biscuit was 3.71±0.07. Adeyeye *et al*. (2014) reported that the moisture content in 100% maize flour cookies was 5.3 per cent. Sharma and Chopra, (2015) reported that moisture content in 100% wheat flour, wheat flour with 40% malted green gram flour and wheat flour with 50% malted green gram flour was 2.0±0.03, 2.6±0.04 and 2.6±0.03 per cent respectively. Vijayakumar *et al*. (2013) reported that moisture content in composition of oat: finger millet: wheat flour (10:10:80 per cent to 40:40:20 per cent) cookies ranged were 4.1 to 3.45 per cent. Beenu and Meenakshi, (2017) reported that moisture content in gluten-free cookies (developed by flour mixture: bajra flour, buck wheat flour and ragi flour of 100:60:40 to 40:100:60 per cent) ranged were 4.8±0.05 to 3.8±0.15 per cent respectively.

1. Moisture

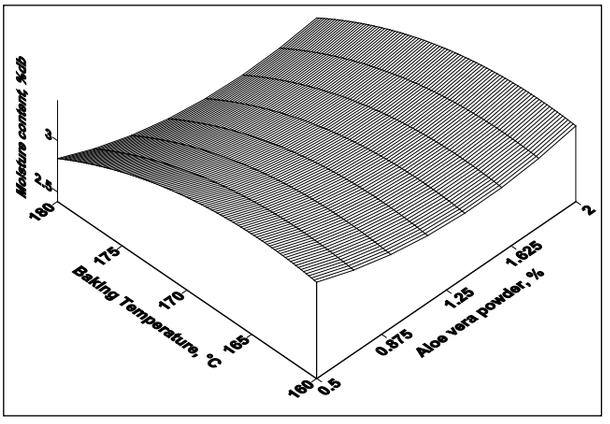

Fig. 1 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Moisture content of the Finger-millet malt: *Aloe vera*: Wheat cookies.

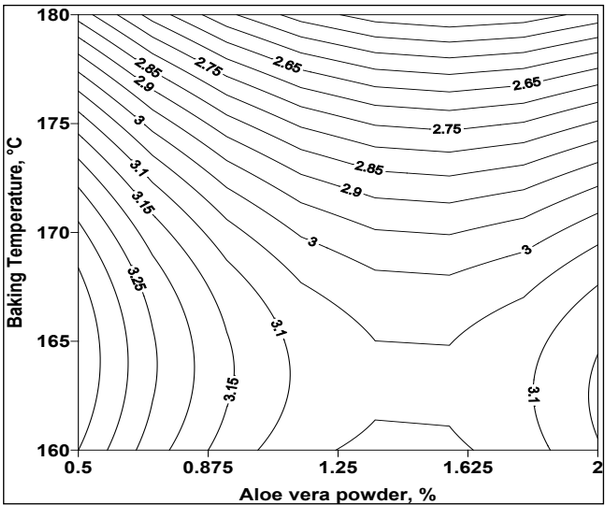

Fig. 1 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Moisture content of the Finger-millet malt: *Aloe vera*: Wheat cookies

Table 3: ANOVA for physico-chemical properties of cookies

(a) Moisture			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	3.23±0.39	3.06±0.35	3.65±0.99	2.26±0.82	3.05
170°C	3.09±0.16	3.18±0.13	2.87±0.07	3.18±0.08	3.08
180°C	3.23±0.13	2.19±0.38	2.09±0.40	2.07±0.03	2.395
Mean	3.183	2.81	2.87	2.503	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.152		0.320		
Baking temp. (Bt)	0.114		0.370		
Interaction (Fc × Bt)	0.038		0.640		
(b) Protein			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	0.91±0.17	0.72±0.28	0.36±0.11	0.74±0.04	0.682
170°C	0.84±0.09	0.83±0.04	0.65±0.04	0.97±0.07	0.822
180°C	1.03±0.07	1.05±0.06	5.32±0.16	2.97±0.09	2.59
Mean	0.92	0.86	2.11	1.56	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.042		0.088		
Baking temp. (Bt)	0.031		0.102		
Interaction (Fc × Bt)	0.010		0.176		
(c) Fat			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	32.26±0.12	32.40±0.20	38.13±0.12	38.73±0.50	35.38
170°C	40.06±0.12	40.26±0.12	40.46±0.12	40.6±0.0	40.34
180°C	40.73±0.12	40.86±0.12	40.46±0.12	40.93±0.12	40.75
Mean	37.86	37.84	39.68	40.08	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.061		0.130		
Baking temp. (Bt)	0.046		0.150		
Interaction (Fc × Bt)	0.015		0.260		
(d) Ash			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	0.93±0.16	0.83±0.24	0.91±0.38	2.58±1.20	1.32
170°C	1.18±0.15	2.53±0.23	4.33±0.10	1.05±0.01	2.27
180°C	1.15±0.45	1.05±0.09	3.41±0.29	1.16±0.36	1.69
Mean	1.08	1.47	2.88	1.59	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.143		0.300		
Baking temp. (Bt)	0.107		0.347		
Interaction (Fc × Bt)	0.035		0.601		

(e) Fiber			**Flour combination**		
Baking temp.	**T_1**	**T2**	**T_3**	**T_4**	**Average**
160°C	1.09±0.04	1.28±0.26	1.52±0.15	2.20±0.35	1.52
170°C	2.72±0.28	3.05±0.06	1.29±0.06	2.17±0.07	2.30
180°C	2.74±0.01	1.34±0.27	4.14±0.06	5.02±0.83	3.31
Mean	2.18	1.89	2.31	3.13	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.101		0.213		
Baking temp. (Bt)	0.076		0.246		
Interaction (Fc × Bt)	0.025		0.427		
(f) Carbohyadrate			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	61.86±0.37	61.68±0.31	55.40±0.68	53.08±1.56	58.00
170°C	50.45±2.53	50.06±0.55	50.38±0.16	52.00±0.11	50.72
180°C	51.10±0.58	53.49±0.17	44.56±0.27	47.18±0.95	49.09
Mean	54.47	71.24	50.11	50.75	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.327		0.688		
Baking temp. (Bt)	0.245		0.794		
Interaction (Fc × Bt)	0.081		1.376		
(g) Hardness			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	11.95±0.04	11.41±0.01	11.61±0.01	13.32±0.01	12.07
170°C	10.66±0.01	14.38±0.01	16.27±0.01	14.36±0.02	13.91
180°C	13.38±0.01	13.89±0.01	14.37±0.01	15.49±0.01	14.28
Mean	11.99	13.22	14.08	14.39	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.059		0.125		
Baking temp. (Bt)	0.044		0.144		
Interaction (Fc × Bt)	0.014		0.250		
(h) Browning index			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160°C	11.73	11.28	12.51	12.49	12.75
170°C	14.51	13.48	9.91	13.67	12.89
180°C	13.05	13.35	11.97	10.96	12.33
Mean	13.09	12.70	11.46	12.73	
	SEm±		**$CD_{at\ 5\ \%}$**		
Flour combination (Fc)	0.251		0.528		
Baking temp. (Bt)	0.188		0.609		
Interaction (Fc × Bt)	0.062		1.056		

Ali *et al*. (2012) reported that moisture content in gram supplemented cookies (composition flour of wheat flour: gram flour of 80:10 per cent to 50:50 per cent) ranged were 2.65±0.11 to 3.70±0.08 per cent. Dipika *et al*. (2012) reported that moisture content in composite flours biscuits (corn, wheat flour, finger millet flour, green gram flour, soy protein isolate, and papaya powder) and another composite flour biscuits (corn flour, wheat flour, malted finger millet flour, germinated green gram, soy protein isolate, and papaya powder) ranged was 2.21±0.14, 2.8±0.40 per cent respectively.

2. Protein

Fig. 2 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the Protein content (%) Finger millet: *Aloe vera*: Wheat flour cookies. The protein content for all the treatments were in the range of 0.36-5.32%. As the *Aloe vera* levels increases from 0.5 to 2.0%, the protein content decreases. Similarly as the baking temperature increases from 160˚C to 180˚C the protein content decreases up to 170˚C and the increasing trend up to 180˚C. As both the *Aloe vera* powder (%) decreases and Baking temperature (˚C) increases, the protein content increases. This can be seen from contour plot Fig. 2(b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the protein content can be seen by the second order polynomial equation (2). The equation is well fitted with $r^2 = 0.820$ and MSE = 1.321.

$$P_r = 2.4094 \times 10^2 - 2.799B_T + 0.0081B_T^2\ 16.812A_v + 0.1097A_v\ B_T - 0.4833\ A_v^2 \quad \ldots(2)$$

Where,

P_r = Protein content, (%)

B_T = Baking temperature, (˚C) and

A_v = *Aloe vera* powder, (%)

Table 3 (b) shows the ANOVA for the protein content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant.

Similar kind of result has been observed by Sahu *et al*. (2015) the protein content in pearl millet raw and roasted cookies was 2.88±0.03 and 2.63±0.02 per cent respectively, sorghum raw and roasted cookies was 3.11±0.10 and 3.07±0.02 per cent and finger millet raw and roasted cookies content was 3.57±0.06 and 3.42±0.01 per cent.

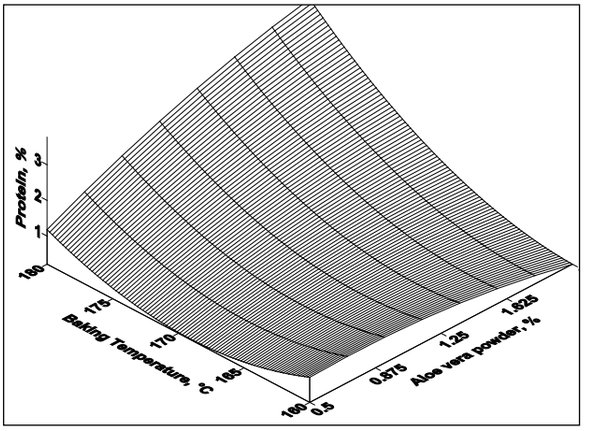

Fig. 2 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Protein content (%) of the Finger-millet: *Aloe vera*: Wheat cookies

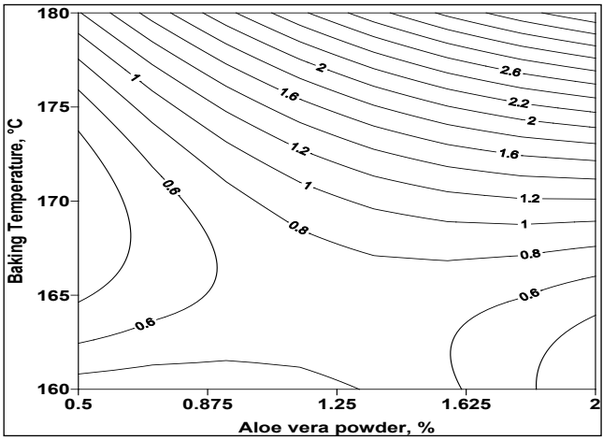

Fig. 2 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Protein content (%) of the Finger-millet malt: *Aloe vera*: Wheat cookies

3. Fat

Fig. 3 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the fat content (%) of Finger millet: *Aloe vera*: Wheat flour cookies. The fat content for all the treatments were in the range of 32.27-40.93%. As the *Aloe vera* (%) increases from 0.5 to 2.0% The fat content increases. Similarly as the baking temperature increases from 160˚C to 180˚C, the fat content increases. As both the *Aloe vera* powder (%) and Baking temperature (˚C) increases, the fat content increases. This can be seen from contour plot Fig. 3 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the fat content can be seen by the second order polynomial equation (3). The equation is well fitted with $r^2 = 0.999$ and MSE = 1.638

$$F = -7.208 \times 10^2 + 8.353B_T - 0.022B_T^2 + 4.355 \times 102A_v - 0.249A_v B_T + 0.24A_v^2 \quad \ldots(3)$$

Where,

F = Fat content, (%)

B_T = Baking temperature, (˚C) and A_v = *Aloe vera* powder, (%)

Table 3 (c) shows the ANOVA for the fat content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant effect on the fat of cookies.

Similar kind of result has been observed in Sahu *et al*. (2015) reported that the fat content in pearl millet raw and roasted cookies was 29.49±0.03 and 28.48±0.02 per cent and sorghum raw and roasted cookies was 30.01±0.16 and 29.34±0.04 per cent respectively.

4. Ash

Fig. 4 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the ash content (%) of Finger millet: *Aloe vera*: Wheat flour cookies.

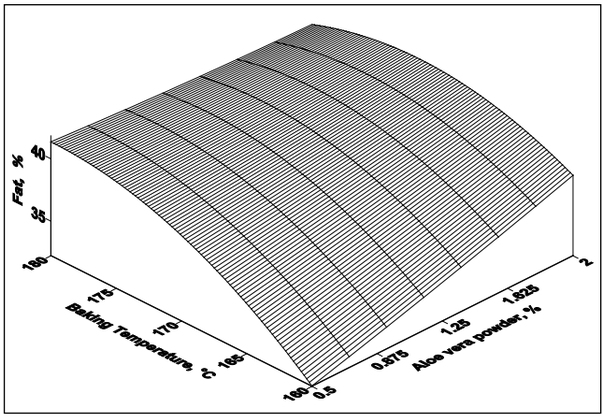

Fig. 3 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the fat content (%) of the Finger-millet: *Aloe vera*: Wheat cookies

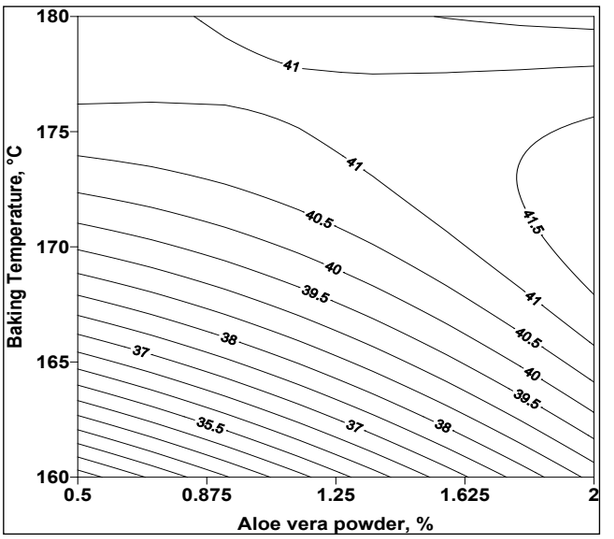

Fig. 3 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the fat content (%) of the Finger-millet malt: *Aloe vera*: Wheat cookies

The ash content for all the treatments were in the range of 0.92-4.33%. As the *Aloe vera* levels increase from 0.5 to 2.0%, the ash content increase. Similarly as the baking temperature (˚C) increases from 160˚C to 180˚C. The ash content increase, as both the *Aloe vera* powder (%) and Baking temperature (˚C) increases the ash content increases upto 2.8% followed by decreasing trend. This can be seen from contour plot Fig. 4(b). The effect of incorporation of *Aloe vera* (%)

and baking temperature (˚C) on the ash content can be seen by the second order polynomial equation (4). The equation is well fitted with $r^2 = 0.817$ and MSE = 1.584

$$A_S = -2.308 \times 10^2 + 2.657B_T - 0.007B_T^2 + 9.2123A_v - 0.0261A_v B_T - 1.6733A_v^2 \quad \ldots(4)$$

Where,

A_s = Ash content, (%),

B_T = Baking temperature, (˚C) and

A_v = *Aloe vera* powder, (%)

Table 3 (d) shows the ANOVA for the ash content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant.

Similar kind of result have been reported Biljana and Jelena, (2011). It is noticed that the ash content for all the treatments were in the range of 0.59-1.48%. Cookies were baked at 180˚C. Sahu *et al*. (2015) reported that ash content in pearl millet raw and roasted cookies was 1.29±0.16 and 1.27±0.01 per cent respectively, sorghum raw and roasted cookies was 1.40±0.01 and 1.34±0.01 per cent respectively and finger millet raw and roasted cookies was 2.44±0.01 and 2.33±0.01 per cent respectively. Kumar *et al*. (2015) reported that ash content in optimized biscuit was 1.51±0.07 per cent. Pushpendra *et al*. (2015) reported that ash content in refined wheat flour cookies was 2.56 per cent and refined flour: foxtail flour: finger millet flour of 95:5:5 per cent to 50:25:25 per cent cookies content ranged was 2.59 to 3.08 per cent.

Sharma and Chopra, (2015) reported that ash content in 100% wheat flour, wheat flour with 40% malted green gram flour and wheat flour with 50% malted green gram flour was 1.64±0.12, 2.28±0.03 and 2.24±0.014 per cent respectively.

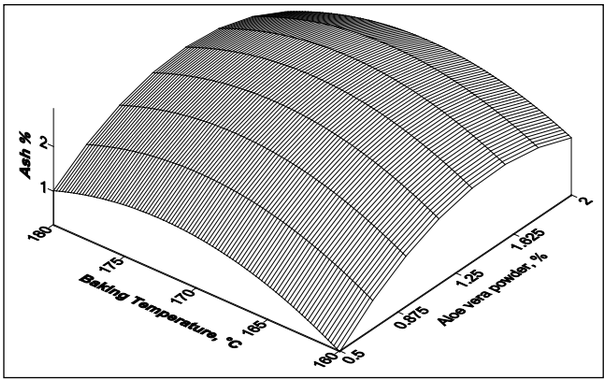

Fig. 4 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Ash content (%) of the Finger-millet: *Aloe vera*: Wheat cookies

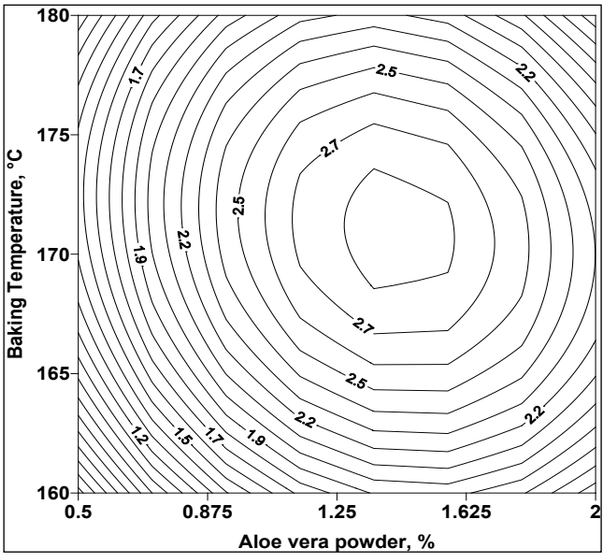

Fig. 4 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Ash content (%) of the Finger-millet malt: *Aloe vera*: Wheat cookies

Vijayakumar *et al*. (2013) reported that ash content in composition of oat: finger millet: wheat flour (10:10:80 per cent to 40:40:20 per cent) cookies ranged were 1.49 to 1.62 per cent. Vasantharuba *et al*. (2012) reported that ash content in wheat flour biscuit and 20% potato flour incorporated biscuits was 1.4, 1.7 per cent respectively. Beenu and Meenakshi, (2017) reported that ash content in gluten-free cookies (developed by flour mixture: bajra flour, buck wheat

flour and *ragi* flour of 100:60:40 to 40:100:60 per cent) ranged were 0.9±0.10 to 0.9±0.10 per cent respectively. Ali *et al*. (2012) reported that ash content in gram supplemented cookies (composition flour of wheat flour: gram flour of 80:10 per cent to 50:50 per cent) ranged were 0.69±0.01 to 1.16±0.02 per cent.

5. Fiber

Fig. 5 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the Fiber content (%) Finger millet: *Aloe vera*: Wheat flour cookies. The Fiber content for all the treatments were in the range of 1.09-5.02%. As the *Aloe vera* levels increases from 0.5 to 2.0%, the fiber content increases. Similarly as the baking temperature increases from 160˚C to 180˚C, the fiber content increases. As both the *Aloe vera* powder (%) and Baking temperature (˚C) increases the fiber content increases. This can be seen from contour plot Fig. 5 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the Fiber content can be seen by the second order polynomial equation (5). The equation is well fitted with $r^2 = 0.919$ and MSE = 1.141

$$F_b = 3.016 \times 10^1 - 0.334B_T + 0.001B_T^2 - 1.241 \times 10^1 A_v + 0.060A_v B_T + 1.106A_v^2 \quad \ldots(5)$$

Where,

F_b = Fiber content, (%)

B_T = Baking temperature, (˚C) and

A_v = *Aloe vera* powder, (%)

Table 3 (e) shows the ANOVA for the Fiber content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature was also significant.

Similar kind of result has been observed in Sahu *et al*. (2015) reported that fiber content in pearl millet raw and roasted cookies was 1.86±0.02 and 1.52±0.01 per cent respectively, and finger millet raw and roasted cookies was 1.59±0.04 and 1.43±0.02 per cent respectively. Adeyeye *et al*. (2014) reported that the fiber content in 100% maize flour cookies was 3.0 per cent.

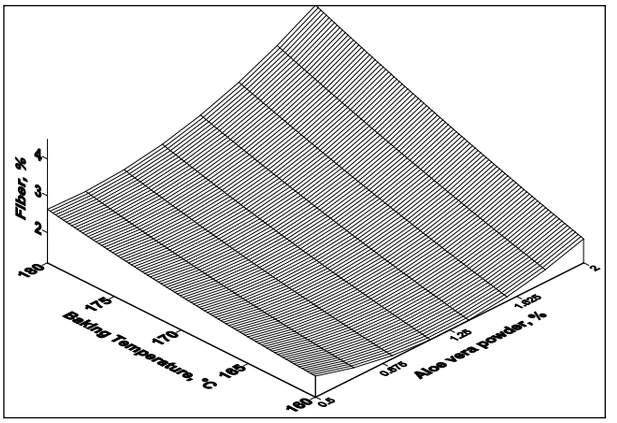

Fig. 5 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Fiber content (%) of the Finger-millet: *Aloe vera*: Wheat cookies

Pushpendra *et al*. (2015) reported that fiber content in refined wheat flour cookies was 2.41 per cent and refined flour: foxtail flour: finger millet flour of 95:5:5 per cent to 50:25:25 per cent cookies content ranged was 2.68 to 2.30 per cent.

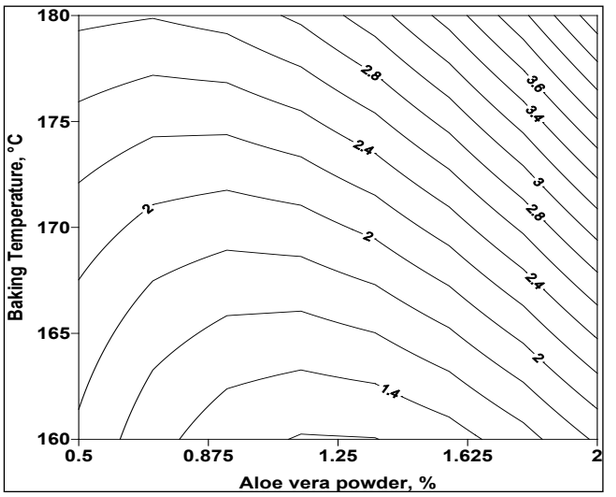

Fig. 5 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Fiber content (%) of the Finger-millet malt: *Aloe vera*: Wheat cookies

Vijayakumar *et al*. (2013) reported that fiber content in composition of oat: finger millet: wheat flour (10:10:80 per cent to 40:40:20 per cent) cookies ranged were 1.89 to 3.05 per cent. Beenu and Meenakshi, (2017) reported that fiber content in gluten-free cookies (developed by flour mixture: bajra flour, buck wheat flour and *ragi* flour of 100:60:40 to 40:100:60 per cent) ranged were 2.3±0.01 to 1.9±0.02 per cent respectively.

6. Carbohydrate

Fig. 6 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (°C) on the carbohydrates content (%) Finger millet: *Aloe vera*: Wheat flour cookies. The carbohydrates content for all the treatments were in the range of 44.56-61.89%. As the *Aloe vera* (%) increases from 0.5 to 2.0%, the carbohydrates content decreases. Similarly as the baking temperature increases from 160°C to 180°C the carbohydrates content decreases. As both the *Aloe vera* powder (%) and as Baking temperature (°C) increases the carbohydrate (%) decreases. This can be seen from contour plot Fig. 6(b). The effect of incorporation of *Aloe vera* (%) and baking temperature (°C) on the carbohydrates content can be seen by the second order polynomial equation (6). The equation is well fitted with r^2= 0.998 and MSE = 1.113

$$C = 9.723 \times 10^2 - 1.019 \times 101\ B_T + 0.028 B_T^2 - 2.375 \times 10^1\ A_v + 0.120 A_v\ B_T + 0.043 A_v^2 \quad \ldots(6)$$

Where,

C = Carbohydrate content, (%)

B_T = Baking temperature, (°C) and

A_v = *Aloe vera* powder, (%)

Table 3 (f) shows the ANOVA for the carbohydrates content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicated that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant at p≤0.01.

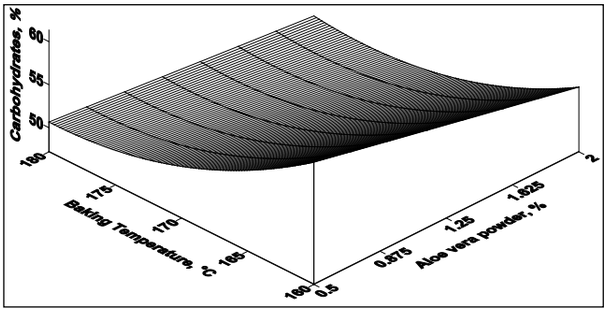

Fig. 6 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Carbohydrates(%) of the Finger-millet: *Aloe vera*: Wheat cookies

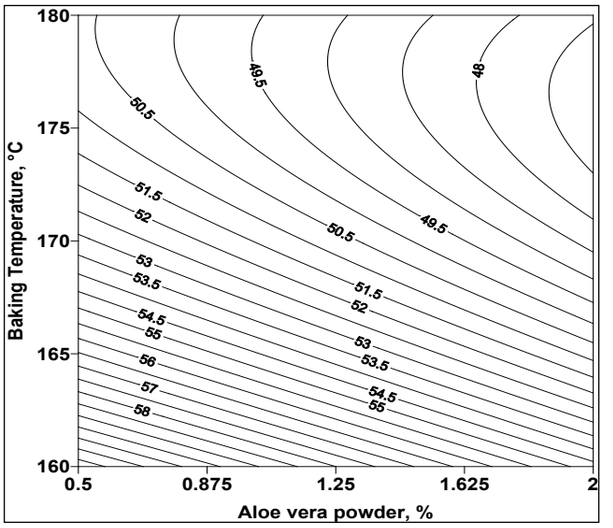

Fig. 6 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Carbohydrates (%) of the Finger-millet malt: *Aloe vera*: Wheat cookies

Similar kind of result has been observed in Vijayakumar *et al*. (2013) reported that carbohydrate content in wheat flour cookies was 63.84 per cent. Vasantharuba *et al*. (2012) reported that carbohydrate content in wheat flour biscuit and 20% potato flour incorporated biscuits was 64.0, 63.9 per cent respectively. Beenu and Meenakshi, (2017) reported that carbohydrate content in gluten-free cookies (developed by flour mixture: bajra flour, buck wheat flour and *ragi* flour of 100:60:40 to 40:100:60 per cent) ranged were 67.3±0.07 to 70.2±0.12 per cent respectively.

7. Hardness

Fig. 7 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the Hardness,of Finger millet: *Aloe vera*: Wheat flour cookies. The hardness for all the treatments was in the range of 10.67-16.28g. As the *Aloe vera* levels increases from 0.5 to 2.0%, the hardness content increase. Similarly as the baking temperature increases from 160˚C to 180˚C, the hardness content increases. As both the *Aloe vera* powder (%) and Baking temperature (˚C) increases, the hardness of cookies increases. This can be seen from contour plot Fig. 7 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the Hardness can be seen by the second order polynomial equation (7). The equation is well fitted with $r^2 = 0.919$ and MSE = 1.141

$$H = -2.174 \times 10^2 + 2.607B_T - 0.007B_T^2 - 0.438A_v + 0.025A_v B_T - 0.916 A_v^2 \quad \ldots(7)$$

Where,

H = Hardness

B_T = Baking temperature, (˚C) and

A_v = *Aloe vera* powder, (%)

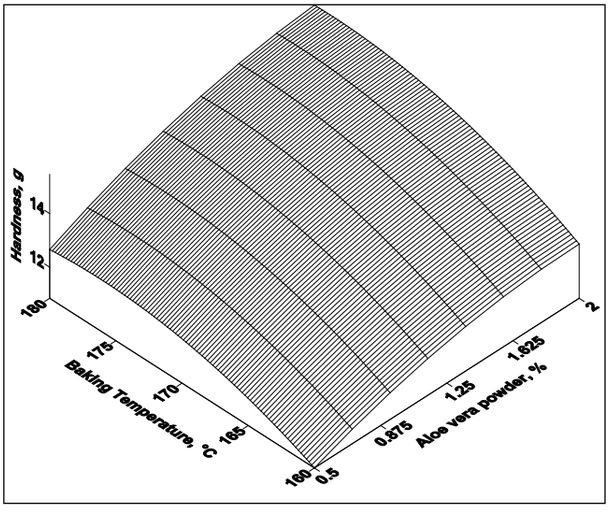

Fig. 7 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Hardness (g) of the Finger-millet: *Aloe vera*: Wheat cookies

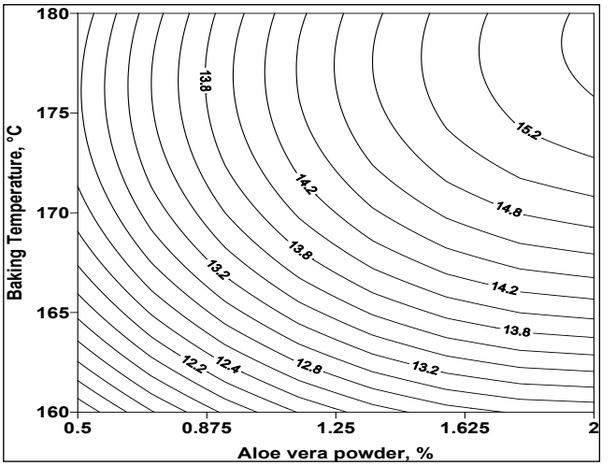

Fig. 7 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Hardness (g) of the Finger-millet malt: *Aloe vera*: Wheat cookies

Table 3 (g) shows the ANOVA for the hardness of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was non significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant.

Similar kind of result has been observed by Das *et al*. (2012), it was reported that hardness of herbal bread ranged between 9 N to 21 N.

8. Browning index

Fig. 8 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (˚C) on the Browning index of Finger millet: *Aloe vera*: Wheat flour cookies. The Browning index for all the treatments were in the range of 9.91-14.515. As the *Aloe vera* levels increase from 0.5 to 2.0, the browning index content increase, similarly as the baking temperature increases from 160˚C to 180˚C, the browning index increased. As the *Aloe vera* powder (%) decreases and Baking temperature (˚C) increases, the browning index decreases. This can be seen from contour plot Fig. 8 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (˚C) on the Browning index content can be seen by the second

order polynomial equation (8). The equation is well fitted with $r^2 = 0.994$ and MSE = 1.832

$$B_I = -2.2 \times 10^2 + 2.6133 B_T - 0.0072 B_T^2 + 1.5 \times 10^1 A_v - 0.111 A_v B_T + 1.301 A_v^2 \quad \ldots(8)$$

Where,

B_I = Browning index, B_T = Baking temperature, (°C) and A_v = *Aloe vera* powder, (%)

Table 3 (h) shows the ANOVA for the browning index content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature are significant.

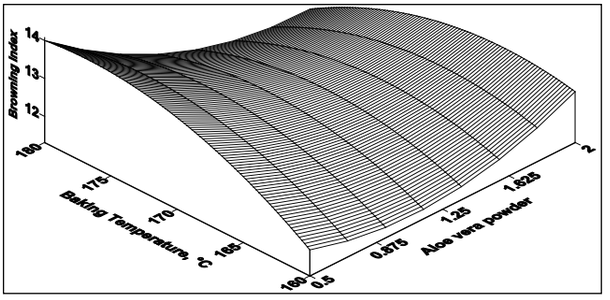

Fig. 8 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Browning Index of the Finger-millet: *Aloe vera*: Wheat cookies

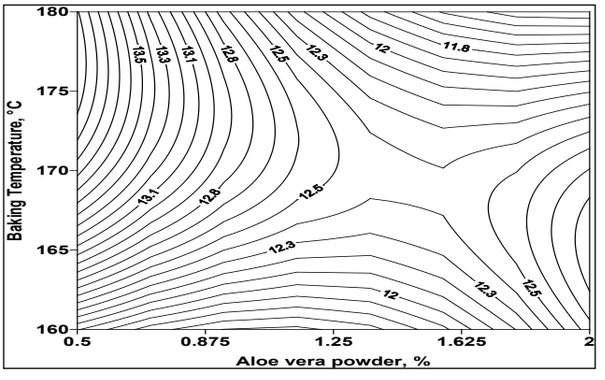

Fig. 8 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Browning Index of the Finger-millet malt: *Aloe vera*: Wheat cookies

9. Baking Temperature

Fig. 9 (a) shows the surface plot showing the effect of incorporation of *Aloe vera* (%) and Baking temperature (°C) on the Baking time of Finger millet: *Aloe vera*: Wheat flour cookies. The Baking time for all the treatments were in the range of 60 to 80 min. As the *Aloe vera* levels increase from 0.5 to 2.0, the Baking time increase, similarly as the baking temperature increases from 160°C to 180°C, the Baking time increased. As both the *Aloe vera* powder (%) increases and Baking temperature (°C) increases, the Baking time decreases. This can be seen from contour plot Fig. 9 (b). The effect of incorporation of *Aloe vera* (%) and baking temperature (°C) on the Baking time content can be seen by the second order polynomial equation (9). The equation is well fitted with r^2=0.999 and MSE = 5.208

$$B_t = 5.608 \times 10^2 - 5.00 B_T + 0.012 B_T^2 + 1.8 \times 10^1 A_v - 0.111 A_v B_T + 1.301 A_v^2 \quad \ldots(9)$$

Where,

B_t = Baking time, (min)

B_T = Baking temperature, (°C) and

A_v = *Aloe vera* powder, (%)

Table 3 (i) shows the ANOVA for the Baking time content of Finger millet malt: *Aloe vera*: Wheat flour based cookies. It indicates that the effect of incorporation of finger millet malt: *Aloe vera*: Wheat flour was significant at p≤0.01. Also the interaction of both the composition (FM: AV: Wheat flour) and Baking temperature was significant.

Similar kind of result has been observed in Swami *et al. (2013) reported that* baking time of finger millet flour cookies ranged between 20 and 34 min.

10. Optimization of finger millet malt: *Aloe vera* powder and wheat flour cookies

The desirable properties of cookies are the cookies should have more protein, more ash, less baking time, less browning index, moderate fibre content, moderate fat content, moderate hardness and moderate fat

content, moderate hardness and moderate moisture content. Based on these properties the contour plots of each parameter were superimposed Fig 10 shows the superimposed contour plots of all the parameters.

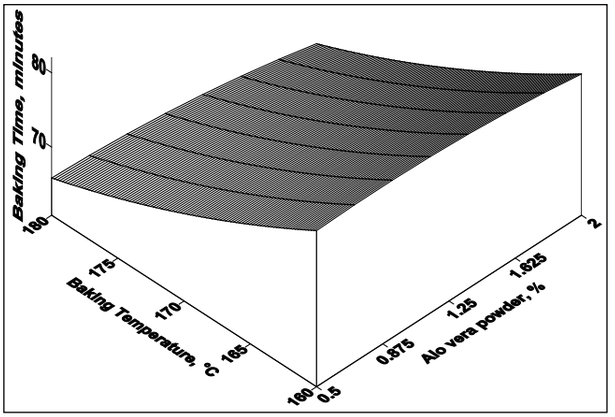

Fig. 9 (a): Surface plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Baking Time (minutes) of the Finger-millet: *Aloe vera*: Wheat cookies

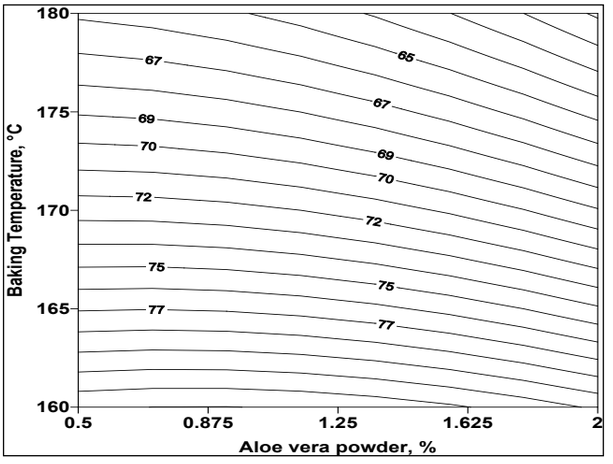

Fig. 9 (b): Contour plot of effect of incorporation of *Aloe vera* powder (%) and baking temperature (°C) on the Baking Time (minutes) of the Finger-millet malt: *Aloe vera*: Wheat cookies

The optimum product have ash 2.8%, baking time 72 min, protein content 2.4%, browning index 2.4%, fiber content 2.4%, fat content 40.5%, hardness 14.2, moderate moisture i.e. 3% were obtained at *Aloe vera* (%) 1.5% and baking temperature 169-171˚C.

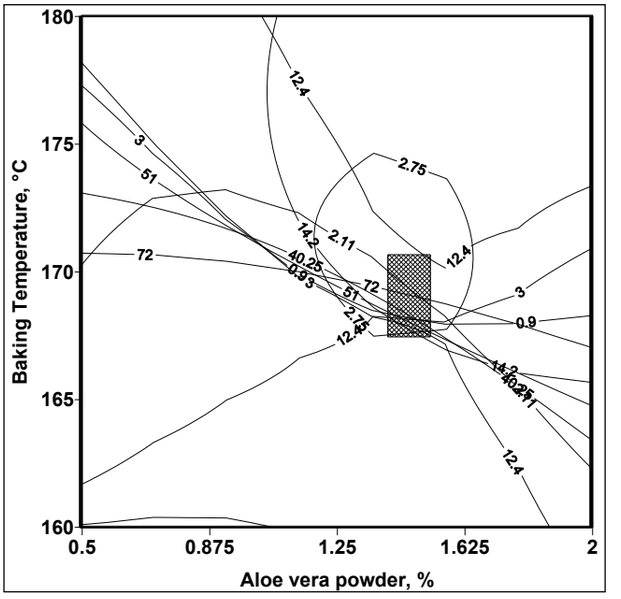

Fig. 10: Superimposed contour plots showing the effect of incorporation of *Aloe vera* powder (%) and Baking temperature on nutritional and quality parameters of cookies i.e. More ash content 2.8; Less baking time 72; more protein content 2.4; less browning index 12.4, moderate fiber content 2.4; moderate fat content 40.5; moderate hardness 14.2; moderate moisture content 3; less baking time 72

Sensory Evaluation of Cookies samples

The data obtained for sensory properties viz. colour, flavor, texture and taste of finger millet malt and *Aloe vera* powder cookies as per the point hedonic scale were determined by semi-trained panel for treatment T_1 to treatment T_{13} are given in Table 4. The average colour scores of finger millet malt and *Aloe vera* powder cookies ranged between 6.89 to 7.41. Table 5(a) ANOVA shows the no significant effect at $p \leq 0.05$.

The average flavor scores of finger millet malt and *Aloe vera* powder cookies ranged between 6.78 to 7.14. Table 5 (b) ANOVA shows the no significant effect at $p \leq 0.05$ on baking temperature and incorporation of finger millet malt and *Aloe vera* powder of cookies on flavor.

The average texture scores of finger millet malt and *Aloe vera* powder cookies ranged between 6.57 to 7.64. Table 5 (c) ANOVA shows the no significant effect at

Table 4: Mean Sensory evaluation of Cookies

Sample Code	Flour combination (Malt: *Aloe vera* powder: Wheat flour)	Baking Temp.	Colour	Flavor	Texture	Taste
A	49.5:0.5:50	160˚C	6.96	7.11	6.57	7.47
B	49.0:1.0:50	160˚**C**	7.29	6.87	6.83	7.31
C	48.5:1.5:50	160˚C	7.31	7.14	7.00	7.44
D	48.0:2.0:50	160˚**C**	7.26	7.02	7.09	7.96
E	49.5:0.5:50	170˚C	7.22	7.03	6.90	8.01
F	49.0:1.0:50	170˚**C**	7.25	7.14	6.72	7.82
G	48.5:1.5:50	**170˚C**	**7.41**	**7.05**	**7.64**	**8.18**
H	48.0:2.0:50	170˚**C**	7.11	6.78	6.78	7.49
I	49.5:0.5:50	180˚C	6.89	7.09	7.46	7.79
J	49.0:1.0:50	180˚**C**	7.22	7.13	7.01	7.45
K	48.5:1.5:50	180˚C	7.09	6.94	6.91	7.42
L	48.0:2.0:50	180˚**C**	7.18	6.83	6.78	7.61

Table 5: ANOVA of sensory

(a) Colour			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160˚C	6.96±043	7.29±0.75	7.31± 0.38	7.26± 0.59	7.205
170˚C	7.22± 0.28	7.25± 0.29	7.41± 0.38	7.11±0.48	7.24
180˚C	6.89 ±0.36	7.22 ±0.52	7.09 ±0.34	7.18 ±0.34	7.09
Mean	7.02	7.25	7.27	7.18	
	SEm±		**$CD_{at\ 5\%}$**		
Flour combination (Fc)	0.084		0.176		
Baking temp. (Bt)	0.063		0.204		
Interaction (Fc × Bt)	0.021		0.353		
(b) flavor			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160˚C	7.11 ±0.36	6.87 ±0.06	7.14 ±0.10	7.02± 0.25	7.03
170˚C	7.03 ± 0.25	7.14 ± 0.20	7.05 ± 0.50	6.78 ± 0.68	7.00
180˚C	7.09 ± 0.30	7.13 ± 0.62	6.94 ± 0.53	6.83 ± 0.29	6.99
Mean	7.07	7.04	7.04	6.87	
	SEm±		**$CD_{at\ 5\%}$**		
Flour combination (Fc)	0.094		0.198		
Baking temp. (Bt)	0.070		0.228		
Interaction (Fc × Bt)	0.023		0.396		

(c) Texture			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160˚C	6.57 ± 0.47	6.83 ± 0.75	7.00 ± 0.60	7.09 ± 0.58	6.87
170˚C	6.90 ± 0.91	6.72 ± 0.36	7.64 ± 0.42	6.6 ± 0.13	6.96
180˚C	7.46 ± 0.62	7.01 ± 0.78	6.91 ± 0.51	6.78 ± 0.38	7.04
Mean	6.97	6.85	7.18	6.82	
	SEm±		**$CD_{at\ 5\%}$**		
Flour combination (Fc)	0.146		0.307		
Baking temp. (Bt)	0.109		0.355		
Interaction (Fc × Bt)	0.036		0.615		
(d) Taste			**Flour combination**		
Baking temp.	**T_1**	**T_2**	**T_3**	**T_4**	**Average**
160˚C	7.47 ± 0.50	7.31 ± 0.51	7.44 ± 0.63	7.96 ± 0.46	7.54
170˚C	8.01 ± 0.72	7.82 ± 0.40	8.18 ± 0.64	7.49 ± 0.36	7.87
180˚C	7.79 ± 0.47	7.45 ± 0.47	7.42 ± 0.42	7.61± 0.39	7.56
Mean	7.75	7.52	7.68	7.68	
	SEm±		$CD_{at\ 5\%}$		
Flour combination (Fc)	0.099		0.209		
Baking temp. (Bt)	0.074		0.242		
Interaction (Fc × Bt)	0.024		0.419		

p≤0.05 on baking temperature and incorporation of *Aloe vera* powder (%) of cookies on flavor.

The average taste scores of finger millet malt and *Aloe vera* powder cookies ranged between 7.31 to 8.18. Table 5 (d) ANOVA shows the no significant effect at p≤0.05 on baking temperature and incorporation of *Aloe vera* powder (%) of cookies on taste.

From the sensory score colour, flavor, texture and taste is non significantly at p≤0.05. it can be concluded that treatment with incorporation of 1.5% *Aloe vera* powder in cookies with baking temperature 170˚C, has the highest sensory score i.e. colour 7.45, flavor 7.05, texture 7.64 and taste 8.18 resulted the best treatment average then all treatments.

Correlation between the optimum parameters and the sensory scores

The optimum product at from section 3.1 *Aloe vera* powder 1.5 % incorporated in cookies and baked at 170˚C temperature the product achieved the desirable qualities i.e. moisture 3%, protein 2.4%, fat 40.5%, ash 2.8%, fiber 2.4%, hardness 14.2, browning index 2.4% and baking time 72 min respectively.

The best sensory score of the product have been obtained from section 3.5 at *Aloe vera* powder 1.5% incorporated in cookies and baked at 170˚C temperature; the product achieved the highest colour 7.45, flavor 7.05, texture 7.64 and taste 8.18. From both physico-chemical properties and the sensory best product achieved i.e. *Aloe vera* powder incorporated at 1.5% and baked at 170˚C.

CONCLUSION

Finger millet malt flour and *Aloe vera* powder prepared by convective hot air drying method to produce good quality of the flour and *Aloe vera* powder can be used as partial replacement for Finger millet malt, for the preparation of cookies.

The best quality of *Aloe vera* powder: finger millet malt cookies 1.5% baked at 170**°C** temperature. With physiochemical properties, moisture 2.87±0.07%, protein 0.65±0.04%, fat 40.46±0.12%, ash 4.33±0.10%, fiber 1.29±0.06%, carbohydrate 50.38±0.01%, hardness 16.28 and browning index 9.913with sensory score color 7.45, flavor 7.05,texture 7.64, taste 8.18 and respectively.

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