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Value addition with flours for increased shelf life of Chapati

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Abstract
Chapatti or flat bread is very popular in the world because it constitutes a major source of dietary protein and calories. There are several forms of flat bread, and the variation is mainly in terms of ingredient, technology, and quality. Several modifications in the formulations have been made in the recent past in order to improve the quality and delicacy of these food products. With increasing urbanization and industrialization, the demand for ready to eat and easy to carry products resembling flat bread in appearance. In this study shelf life of chapatti and its flexibility was tried to improve by adding several ingredients like jowar, buckwheat, hot water and oil in the wheat flour. Variables such as jowar, buckwheat and oil are added at three different levels as 20%, 30%, 40%; 20%, 30%, 40%; 10%, 15% and 20%respectively. The chapatti was prepared by traditional method and then undergoes the thermal process and then stored at 5°C in refrigerator in LDPE packaging material and then followed the results for shelf life of chapatti in equal interval of 24 h for 4 readings for 0th h, for 24th h, 48th h and 72th h and no spoilage were found in any sample and the overall acceptability is good rated to jowar sample and poor was rated for control sample. The sensory analysis was done using 9-point hedonic scale and from mean sensory score it was predicted that the jowar sample had significantly superior acceptability as compared to others and control sample had significantly poor acceptability. At the end of the test, it was found that buckwheat sample was best accepted while control sample was having poor acceptability. Results from the time measurements and microbiological tests showed that the product was in acceptable condition throughout the storage period.

Keywords: Buckwheat, Jowar, flour, Chapati

Introduction
Chapatti is made from wheat flour for which wheat is grinded to make flour and wheat (*Triticum aestivum*) is a major cereal crop used for the preparation of bakery products such as bread, biscuits and cakes all over the world. However, in India, about 75% of the wheat grown is used for the preparation of chapati, unleavened flat bread, which is prepared from whole wheat flour. Chapati is the main traditional wheat based food, consumed by majority of the population in Indian subcontinent and also widely consumed in UK and other countries by Asian ethnic community. The desired sensory quality characteristics of chapati are greater pliability, soft texture, light creamish brown color, slight chewiness and baked wheat aroma. Carbohydrate is the major component present in whole wheat flour and among the carbohydrates, starch is the major component and arabinoxylan is the minor component. (Hemalatha, *et al.,* 2013) [2].

Chapati, a flat and unleavened baked product made from whole wheat flour, is the staple diet of majority of population of India and its subcontinent. Whole wheat flour is mixed with water into a dough and the dough is normally given a minimum rest period of 15–30 min before it is sheeted to a thickness of about 1.5–2 mm. The dough thus sheeted is cut into a circular shape of 12–15 cm diameter and baked on a hotplate at 220˚C and finally puffed on a live flame for a few seconds. It is generally consumed hot along with other adjuncts. Complete and full puffing, soft and pliable texture as well as light creamish brown color with dark brown spots is some of the important physical attributes of good quality chapati. Hemalatha, *et al.* (2007) [1].

Chapattis are an economical source of protein, and contribute to satiety through abundant dietary fiber, that reduces constipation and diverticular disease, rates of chronic bowel disease and diet-related cancers (Maneepun *et al*., 2005). Ideally the chapatti is creamy in color, cooked with a minimum of small brown spots and fully puffed so that two distinct layers are present. The chapatti should be easily torn and pliable so that it can be folded by the thumb and forefinger to produce a small scoop for holding vegetables or curried preparations.

A wheatish aroma and taste is desirable with a non sticky, soft chewing feel in the mouth.

Buckwheat is naturally gluten free and has a nutty flavor. When it is milled it becomes a great substitute for wheat flour with an added benefit of having a high protein content. Buckwheat (Fagopyrum esculentum) is a pseudocereal, a low input crop with relatively high yields that can be grown in marginal lands. Buckwheat has been providing essential nutrients, vitamins, energy, and fiber to humanity for approximately 8,000 years. Its grain has unique triangular shape with size of wheat kernel. Buckwheat contains higher levels of zinc, copper, and manganese than other cereal grains, and the bioavailability of zinc, copper, and potassium from buckwheat is quite high. One cup (155g) of buckwheat provides Reference Daily Intake (RDI) of manganese 34%, copper 28%, magnesium 21%, dietary fiber 18% and phosphorus 17%. As it contains no gluten that makes it suitable for people who are sensitive to wheat or other grains that contain gluten. Top buckwheat production in thousand tons is Russia, 700; China, 662; Ukraine, 167; France, 111; US and Poland, 83 each and Brazil 64.

Chapatti is one of the daily food needs of human being. It provide sufficient amount of energy and calories for a healthy living. Due to increasing work load and lack of time it has become very difficult to make fresh chapatti at every meal. As the chapatti after some time become hard and has rubbery effect in them, so it become the necessity and find some solution to

i. To prepare different varieties of chapatti with jowar, buckwheat, oil and hot water.
ii. To study the sensory attributes of the developed chapaties over time.
iii. To study the microbial analysis of the developed chapatti over time.
iv. To evaluate the shelf life with the help of ANN.

Hardeep Singh Gujral and Ambika Pathak (2002) reported that Chapaties were prepared from composite flours and the tensile properties of the chapaties were determined using an Instron Universal Testing Machine. Parameters like extensibility, peak force to rupture, modulus of deformation and energy to rupture were used to describe texture. The whole wheat flour was replaced with flours from rice, corn, barley, millets and black gram. Effect of additives like skim milk powder, wet gluten, liquid shortening, carboxymethylcellulose, glycerol monosterate, sodium caseinate and diastase on chapati texture was also evaluated. Upon storage up to 24 h, the extensibility and energy to rupture decreased whereas modulus of deformation and peak load to rupture increased. It was observed that chapaties made from some composite flours showed higher extensibility even after 24 h of storage, especially barley. Some of the additives like wet gluten and sodium caseinate also significantly improved the texture of chapatti.

Nisar Hussain *et al.* (2017) developed buckwheat cookies supplemented with wheat flour. Buckwheat and wheat flour were examined for their proximate composition. Buckwheat flour contained 11.6% moisture, 15.79% crude protein, 1.81% crude fat, 1.83% ash, 0.70% crude fibre content and 68.27% NFE, while wheat flour contained moisture content 13.12%, crude fibre content 1.93%, crude fat 1.42%, crude protein content 12.53%, ash content 1.57% and 69.43% NFE, respectively. Wheat flour was incor-porated into buckwheat flour at 10, 20, 30, 40 and 50% ratio to make composite flour and the developed cookies were analysed for quality evaluation. Supplementation of wheat flour significantly influenced the proximate and mineral composition of buckwheat flour based cookies. Moisture contents, crude fibre contents and NFE (Nitrogen Free Extract) increased, whereas crude fat, crude protein and ash contents decreased. Mineral contents (Fe, Ca, K, Zn and Mg) of developed buckwheat cookies decreased with increase in wheat flour supplementation levels. Sensory characteristics of supplemented cookies increased with increase in supplementation levels of wheat flour and were acceptable by judges in terms of test, colour, texture and overall acceptability. Cookies developed from C 50% C supplementation level of wheat flour got maximum scored points while C0 control C0 was found to be more nutritious and gluten free having more crude protein and mineral contents when compared to supplemented cookies.

Talwinder S Kahlon *et al.* (2018) conducted the study of sensory evaluation of whole grain, gluten-free, Buckwheat (B), Peanut Meal (P) and Beets (B) flatbreads was conducted. The flatbreads were BPB, BPB-Onions, BPB-Garlic and BPB-Ginger. Buckwheat is an ancient grain, gluten-free and good source of many essential minerals. Peanut Meal was utilized to formulate higher protein flatbreads and to add value to this low value farm byproduct. Fresh beets a vegetable with bile acid binding and health promoting potential was used to increase vegetable consumption. Onions, garlic and ginger contain many healthful phytonutrients. The levels of buckwheat, peanut meal, beets, onions, garlic and ginger were determined by consensus of the laboratory personnel. Flatbread dough was prepared using 55-83ml water per 100g as is ingredients. The ingredients were Buckwheat flour, Peanut Meal and Beets (22-33%) as is basis. Onions, Garlic and Ginger flatbreads contained 33%, 8% and 20% of the respective ingredients. 50g flatbread dough was pressed between parchment paper in Sol Luna tortilla press to about 8-inch circle. They were cooked in flatbread cooker for 2-2.25 minutes at (165-195°C). Seventy-seven in-house volunteers evaluated Color/Appearance, Texture/Mouth feel as well as Acceptance of the four kinds of flatbreads tested to be statistically similar. Odor/Aroma of BPB-Onions was significantly ($p \leq 0.05$) higher than BPB flatbreads. Taste/Flavor of the BPB-Onions and BPB-Garlic was similar and significantly better than BPB-Ginger and BPB flatbreads. For BPB-Ginger flatbreads these values were also significantly higher than BPB. The acceptance of the flatbreads tested was BPB-Onions 79%, BPB-Garlic 78%, BPB 68% and BPB-Ginger 66%. These flat breads used only 3-4 ingredients and could be made in any house kitchen or commercial production. These whole gain, high protein, gluten-free, vegetable, flatbreads offer tasty, nutritious and healthy choice to all and those sensitive to gluten.

Hemalatha *et al.* (2013) [2] reported the influence quality of bakery products. Arabinoxylans were isolated from good and poor chapati making varieties, added them at different levels (0.25 and 0.5 g/100g) to the same flour, interchanged with other varieties and determined the effect of arabinoxylans. Rheological properties were improved upon adding isolated arabinoxylans of good chapati making varieties to flours. Interestingly, addition of isolated arabinoxylans of good chapati making varieties to poor chapati making varieties had significantly improved the chapati quality. Sensory studies showed that chapatis prepared from flour added with arabinoxylans of good chapati varieties had soft texture and

high overall quality scores. These changes are attributed to differences in their arabinose/xylose ratio. Thus, results indicated that addition of isolated arabinoxylans of good chapati making flour improved the chapati quality of poor chapati making flour.

S. Rao, G. Rao (1997) stated that **s**orghum flours (quality grades-25 and 15% polishing) were incorporated into wheat flour at 5, 10, 15 and 20% levels. The water absorption of flour blends and dough strength decreased with the increase in the level of sorghum flour. The bread volume decreased with increasing level of sorghum substitution. The crumb colour changed from creamish white to dull brown and a gradual hardening of crumb texture was observed as the addition of sorghum increased. Replacement of wheat flour upto 15 and 10% with 75 and 85% extraction rate sorghum flours, respectively produced acceptable breads.

Materials and methods

Table 3.1: Experimental Plan

S. No	Variable	Level	Description
1	Product	1	Chapati
2	Variables	4	Jowar, Buckwheat, Hot Water, Oil
3	Levels	3	Jowar (20%, 30%, 40%) Buckwheat (20%, 30%, 40%) Oil (10%, 15%, 20%)
4	Analysis	3	i. Sensory (9 point hedonic scale) ii. Microbial (Yeast and mold) iii. Calculation and estimation of shelf life (Artificial Neural Network)
5	Packaging Material	1	LDPE
6	Statistical Analysis	1	ANOVA

Materials

Materials used in chapatti making:

Whole wheat flour was taken of Aashirvaad company, salt of Tata brand was used. Oil, Buckwheat flour, Jowar flour are procured from market. The utensils such as plate for dough kneading, rolling pin, rolling board, iron tawa, pair of tongs are used.

Materials used in microbial analysis

The equipments used for microbial analysis are laminar air flow chamber, colony counter, electronic balance and incubator and the glassware used are test tubes, sterile disposable petri plates, pipettes (1 ml), beakers, sterile disposable micropipette tips, measuring cylinders and spatulas.

Equipments

Laminar Air Flow Chamber
Incubator
Digital Weighing Balance
Digital Colony Counter
Autoclave

Chemicals used

Ringer's Solution
Potato Dextrose Agar

Formulation and preparation of chapatti

Table 3.2: Formulation and preparation of chapati

Treatments/Ingredients		Flour (gm)	Salt (gm)	Distilled Water (ml)	Jowar (gm)	Buckwheat (gm)	Oil (ml)	Hot Water (ml)
Control	T_0	200	1.2	158	0	0	0	0
Jowar 20%	T_1	200	1.2	158	40	0	0	0
Jowar 30%	T_2	200	1.2	158	60	0	0	0
Jowar 40%	T_3	200	1.2	158	80	0	0	0
Buckwheat 20%	T_4	200	1.2	158	0	40	0	0
Buckwheat 30%	T_5	200	1.2	158	0	60	0	0
Buckwheat 40%	T_6	200	1.2	158	0	80	0	0
Oil 10%	T_7	200	1.2	158	0	0	20	0
Oil 15%	T_8	200	1.2	158	0	0	30	0
Oil 20%	T_9	200	1.2	158	0	0	40	0
Hot Water	T_{10}	200	1.2	0	0	0	0	158

Preparation of chapati in laboratory

- **Flour was chosen:** Traditional roti recipes call for chapati flour, which is also known as durum wheat atta. Chapati flour is a finely ground whole wheat flour. It's the traditional choice for making roti.
- **Used water:** Distilled water was taken as it contains no impurities and prevents side reactions and contamination of products.
- **Flour and salt were shifted:** The flour was mixed in a large mixing bowl; salt was added and mixed thoroughly.
- **Variable was added:** The different materials were added in the flour separately.
- **Water was added.** Distilled water was slowly added to the flour. The dough will be sandy at first, but as more was added, it started to pull together to form a ball.
- **Dough was kneaded:** Once your ball of dough has formed, knead by hand for about five minutes. This will help gluten proteins form.
- **Dough was kept for rest:** Once dough kneading was finished, the dough was rested for approximately 30 minutes. Letting the dough rest resulted in softer rotis. The gluten formed during the kneading process was relaxed.
- **Cooking surface was heated:** To cook the chapati, a

cast-iron skillet with a diameter of at least 8-9 inches, or a traditional iron tawa was used.

- **Dough is needed and divided:** The rested dough was taken and kneaded again for a minute or two. The dough was divided into even balls of the same weight (approximately 25gram).
- **Balls were rolled out:** One ball was taken and it was flattened between the palms. It was lightly dusted both sides with flour, and began to roll out the ball on the powdered surface with powdered rolling pin. Rolling pin was constantly moved in order to get as circular of a shape as possible.
- **Chapati was cooked:** The flattened dough was placed on the hot pan or tawa for about 15-30 seconds. The roti became ready to be flipped once the bubble form was seen on the top side.
- **Finished cooking the roti:** The chapatti was cooked on the other side for about another 30 seconds. The roti began to puff.

The bunch of roti was packed in LDPE packaging material and was store in the refrigerated temperature at 5ºC for 4 days. After four days of storage, the chapatti was taken out and the elasticity and shelf life were being tested at interval of 24 hours. Thus the differently prepared chapaties are tested at 24 hr, 48 hr and 72 hr. Sensory test and microbial test was carried out at that interval.

Product standardization

Product standardization is one of the most critical steps in processing because the acceptability and sensory quality of the product mostly depend upon it though the effect of the way of processing may also be there. Here, we made Chapati by using wheat flour, distilled water, salt and variables as jowar, buckwheat, oil and hot water. For making chapatti we have taken 25 gram of dough.

The control chapatti was taken as wheat flour of Aashirvaad whole wheat atta. Distilled water and a little amount of salt were added for the preparation of control sample.

Microbial analysis

Microbiological analysis during storage conditions

Table 3.3: Microbial analysis

Packaging material	Product	Type	Levels	Microbial analysis (h)
LDPE	Chapati	jowar	3	0, 24, 48, 72
		buckwheat	3	0, 24, 48, 72
		hot water	1	0, 24, 48, 72
		oil	3	0, 24, 48, 72

Sensory evaluation

Sensory attributes including colour, texture, taste, appearance and overall acceptability is determined by hedonic rating tastes as recommended by Ranganna (2007). Hedonic rating taste is used for evolution of sensory characteristics. This test is used for acceptability by consumer for the product. The detailed methodology is presented below. A panel of eight expert judges of different age group having different habit will be selected and sample will be serving to them. The expert panelist will be asked to rate the acceptability of the product through sense organs on scale of nine (9) points ranging from like extremely to dislike extremely.

Packaging material used

The Low-Density Polyethylene (LDPE) packaging material was used during the experiment. It's a thermoplastic made from monomer ethylene and the first grade of polyethylene, produced in 1933 by Imperial Chemical Industries (ICI) using a high-pressure process via free radical polymerization.

Plate 1: LDPE Packaging

Pouch standardization

After many trials these aspects had been standardized for each product. The final product of the chapatti which was weighed 25 gram and of the size diameter 13cm and thickness 0.2 cm and the total diameter of the pouch was 20×14 cm.

The experiments were conducted for "Increasing Sheelf Life of Chapati by Value Addition". The present investigation was under taken to evaluate the quality as well as acceptability of utilization of different variables such as jowar, buckwheat, hot water and oil for the preparation of chapatti. The sensory and microbial evaluation had been carried out.

Studies based on sensory properties were determined for cooked chapatti like flavour, taste, texture appearance and overall acceptability. The chapatti was packed in LDPE bags and stored at 5 °C. The shelf-life studies were conducted at the interval of 24 to 72 hours. The result of the study are being presented and discussed further.

Product Development

The product development was done by the utilisation of jowar, buckwheat, hot water and oil along with wheat flour increases the shelf life and flexibility of chapatti. From all the preparations, it was seen that wheat flour with buckwheat flour (40%) was accepted by panel judges depending on sensory evaluation and was best according to shelf life. LDPE is the packaging material used for the chapatti. On the basis of above results revealed in the present study it might be concluded that this formulation of chapatti will satisfy consumer and will be widely accepted in the market.

Sensory attributes of chapatti influenced by storage period and using different variables

Sensory attributes of chapatti were evaluated for fresh condition and at 24 hour interval up to 72 hours at 5^0C temperature. Nine point hedonic rating test method was used

for the evaluation of different samples of chapatti. Different attributes such as color, taste, texture, appearance and overall acceptability were evaluated. The overall acceptability of each variable has been taken for the evaluation.

Effect of different level of jowar on overall acceptability analysis of chapatti at different storage time

The effect of different level (20%, 30%, and 40%) of jowar on chapatti is presented in table 4.1. The highest score for overall acceptability at 0th hour was obtained for T_3, at 24th hour it was for T_3, at 48th hour it was for T_3 and at 72th hour it was for T_3. The lowest score for overall acceptability at 0th hour was obtained for T_2, at 24th hour it was for T_0, at 48th hour it was for T_0 and at 72th hour it was for T_0.

Table 4.1: Effect of different level of jowar on overall acceptability analysis of chapatti at different storage time

Storage Time/ Samples	0	24	48	72
T_1	8.75	8.25	8.125	7.375
T_2	8	7.75	7.25	6.75
T_3	8.625	8	7.87	7.325
T_0	8.625	7.5	7.125	6.375
F.Test	S			
C.D.	0.0001			
S.Ed	0.155			

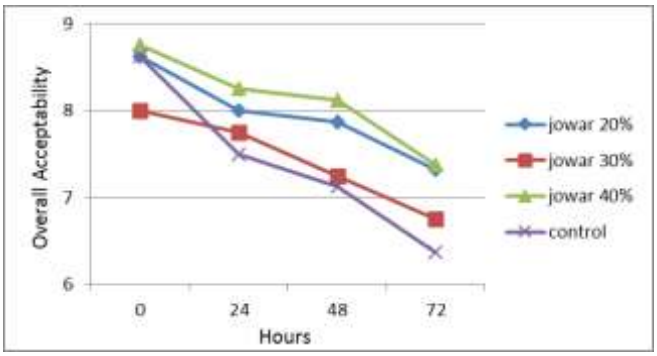

Fig 1: Effect of different level of jowar on overall acceptability analysis of chapatti at different storage time

Effect of different level of buckwheat on overall acceptability analysis of chapatti at different storage time

The effect of different levels (20%, 30%, and 40%) of buckwheat on chapatti is presented in table 4.2. The highest score for overall acceptability at 0th hour was obtained for T_0 sample, at 24th hour it was for T_6, at 48th hour it was for T_6 and at 72th hour it was for T_6. The lowest score for overall acceptability at 0th hour was obtained for T_4, at 24th hour it was for T_4 and T_0, at 48th hour it was for T_4 and at 72th hour it was for T_0.

Table 4.2: Effect of different level of buckwheat on overall acceptability analysis of chapatti at different storage time

Storage Time/ Samples	0	24	48	72
T_4	8.25	7.5	7	6.5
T_5	8	7.75	7.5	7.25
T_6	8.5	8.125	8	7.75
T_0	8.625	7.5	7.125	6.375
F.Test	S			
C.D.	0.007			
S.Ed	0.29			

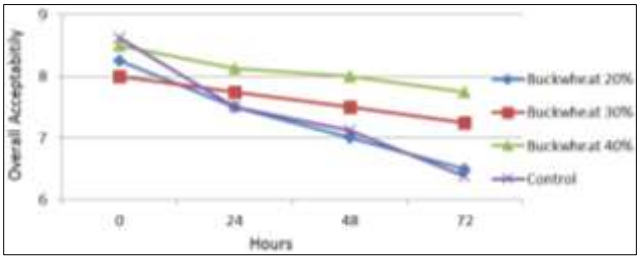

Fig 2: Effect of different level of buckwheat on overall acceptability analysis of chapatti at different storage time

Effect of different level of oil on overall acceptability analysis of chapatti at different storage time

The effect of different level (10%, 15%, and 20%) of oil on chapatti is presented in table 4.3. The highest score for overall acceptability at 0th hour was obtained for T_7, at 24th hour it was for T_7, at 48th hour it was for T_7 and at 72th hour it was for oil T_7. The lowest score for overall acceptability at 0th hour was obtained for T_9, at 24th hour it was for T_0, at 48th hour it was for T_0 and at 72th hour it was for T_0.

Table 4.3: Effect of different level of oil on overall acceptability analysis of chapatti at different storage time

Storage Time/ Samples	0	24	48	72
T_7	8.75	8.625	8.5	8.25
T_8	8.625	8.375	8.25	7.75
T_9	8.375	8.125	7.825	7.25
T_0	8.625	7.5	7.125	6.375
F.Test	S			
C.D.	0.0004			
S.Ed	0.18			

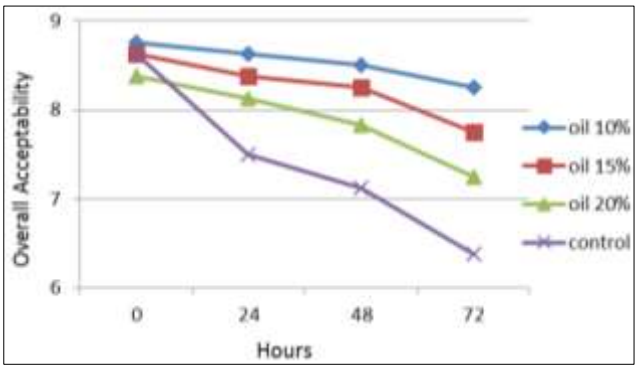

Fig 3: Effect of different level of oil on overall acceptability analysis of chapatti at different storage time

Out of three levels of jowar, buckwheat and oil the best considered are Jowar 40% (T_3), Buckwheat 40% (T_6) and Oil 10% (T_7), thus further analysis was done by taking these three (T_3, T_6 and T_7) and hot water (T_{10}) along with Control (T_0).

Effect of jowar, buckwheat, hot water and oil on flavour analysis of chapatti at different storage time

The effect of different contents of chapatti is presented in table 4.13. The highest score for flavour at 0th hour was obtained for T_0, at 24th hour it was for T_6 and T_3, at 48th hour it was for T_3 and at 72th hour it was for T_6 and T_3. The lowest score for flavour at 0th hour was obtained for T_{10} and T_7, at 24th hour it was for T_0, at 48th hour it was for T_0 and at 72th hour it was for T_0. Control fresh is the sample prepared at the particular time interval for better comparison of different variables to the freshly prepared chapatti.

Table 4.13: Flavour analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Storage Time/ Samples	0	24	48	72
Control Fresh		8.25	8.25	8.125
T_0	8.625	7.5	7.125	6.375
T_{10}	8.125	7.75	7.5	7.375
T_7	8.125	8	7.5	7.125
T_6	8.25	8.125	8	7.5
T_3	8.5	8.125	7.75	7.5
F.Test	S			
C.D.	0.003			
S.Ed	0.42			

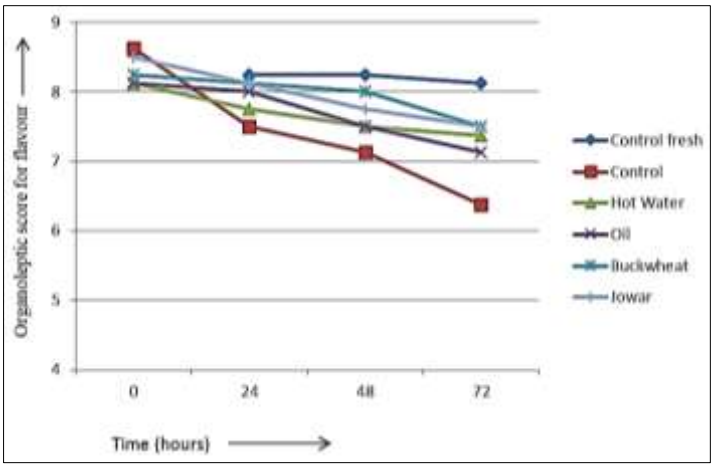

Fig 4: Flavour analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Effect of jowar, buckwheat, hot water and oil on texture analysis of chapatti at different storage time

The effect of different contents of chapatti is presented in table 4.14. The highest score for texture at 0^{th} hour was obtained for T_6 and T_3 at 24^{th} hour it was for T_3, at 48^{th} hour it was for T_3 and at 72th hour it was for T_6. The lowest score for texture at 0^{th} hour was obtained for T_0, at 24^{th} hour it was for T_0, at 48^{th} hour it was for T_0 and at 72^{th} hour it was for T_0.

Table 4.14: Texture analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Storage Time/ Samples	0	24	48	72
Control Fresh		8.75	8.25	8.25
T_0	7.875	6.125	5.75	5.25
T_{10}	8	7.5	7.5	7
T_7	8.5	8	7.75	7
T_6	8.625	8	7.875	7.5
T_3	8.625	8.25	8.125	7.375
F.Test	S			
C.D.	0.00003			
S.Ed	0.306			

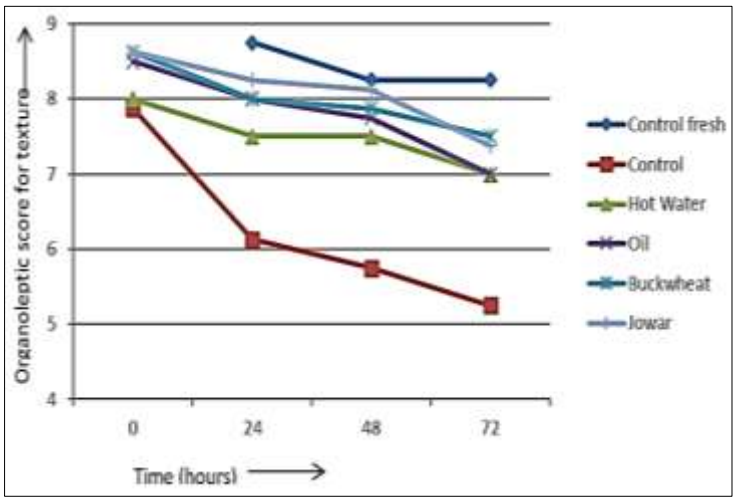

Fig 5: Texture analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Effect of jowar, buckwheat, hot water and oil on appearance analysis of chapatti at different storage time

The effect of different contents of chapatti is presented in table 4.15. The highest score for appearance at 0th hour was obtained for sample with T_3, at 24th hour it was for T_3, at 48th hour it was for T_6 and T_3 and at 72th hour it was for T_3. The lowest score for appearance at 0th hour was obtained for T_0 and T_{10}, at 24th hour it was for T_0, at 48th hour it was for T_0 and at 72th hour it was for T_0.

Table 4.15: Appearance analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Storage Time/ Samples	0	24	48	72
Control Fresh		8.5	8.5	8
T_0	8.375	7.125	5.625	5.375
T_{10}	8.375	8	7.5	7.25
T_7	8.625	8	7.625	7.125
T_6	8.5	8	8	7.5
T_3	8.875	8.25	8	7.625
F.Test	S			
C.D.	0.002			
S.Ed	0.529			

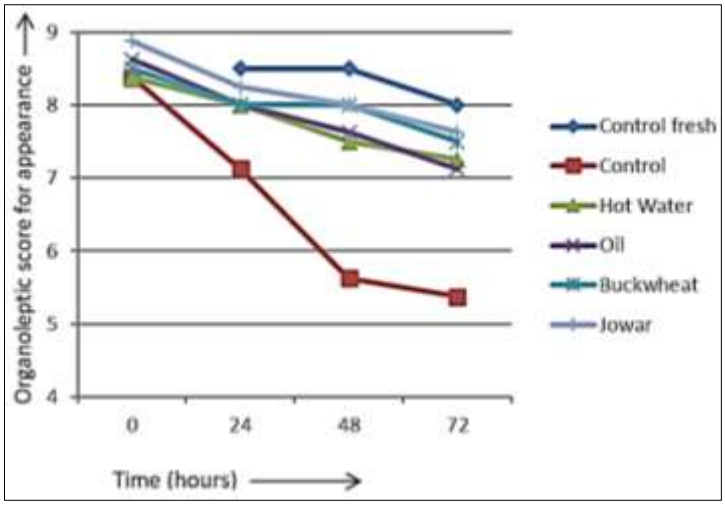

Fig 6: Appearance analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Effect of jowar, buckwheat, hot water and oil on overall acceptability analysis of chapatti at different storage time

The effect of different contents of chapatti is presented in table 4.16. The highest score for overall acceptability at 0th hour was obtained for T_3, at 24th hour it was for T_7, at 48th hour it was for T_6 and T_7 and at 72th hour it was for T_6 and T_7. The lowest score for overall acceptability at 0th hour was obtained for T_0, at 24th hour it was for T_0, at 48th hour it was for T_0 and at 72th hour it was for T_0.

Table 4.16: Overall acceptability analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Storage Time/Samples	0	24	48	72
Control Fresh		8.5	8.46875	8.1875
T_0	8	6.71875	5.625	5.3125
T_{10}	8.25	7.84375	7.406	7.375
T_7	8.5	8.25	8	7.75
T_6	8.5	8.125	8	7.75
T_3	8.625	8	7.87	7.325
F.Test	S			
C.D.	0.0007			
S.Ed	0.37			

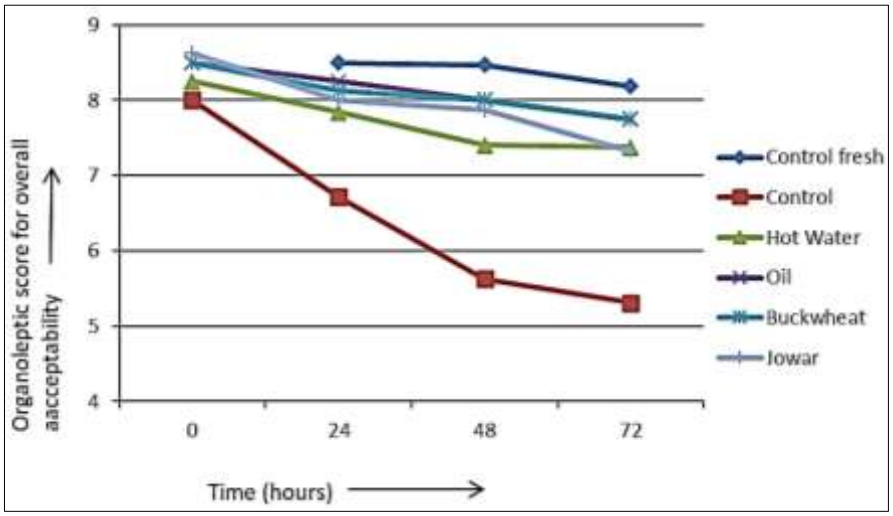

Fig 7: Overall acceptability analysis of chapatti with jowar, buckwheat, hot water and oil at different storage time

Microbiological analysis during storage conditions

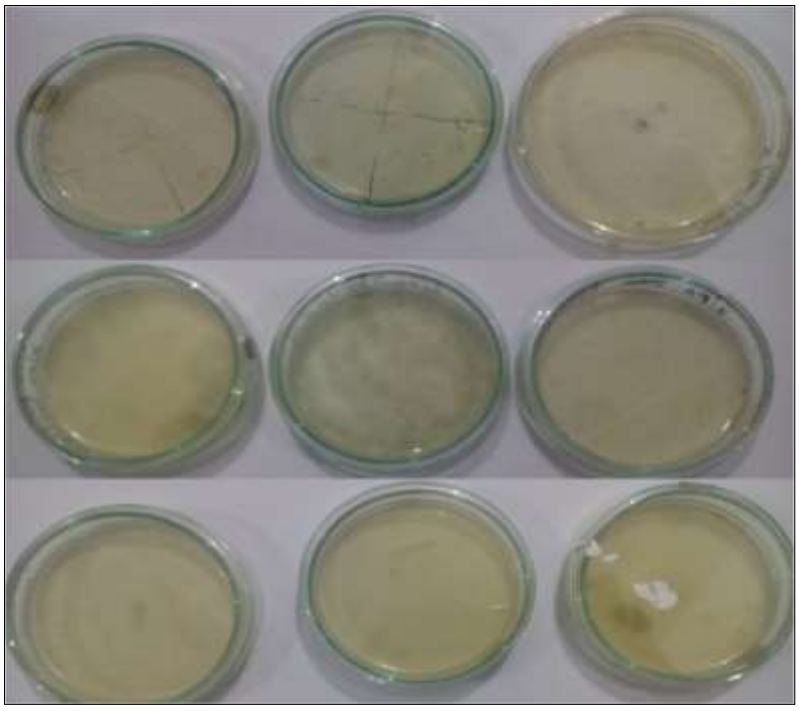

Fig 8: Microbial analysis for buckwheat, jowar and control at 72 h

The microbial analysis shown in Fig 8 for buckwheat, jowar and control sample at 48 hour and as per the observation the growth of yeast and mold is very small. Since a representative portion of a sample is analysed, the results indicate that no growth was obtained in the sample portion tested. The unit of measurement for the enumeration of microbes is a colony forming unit (CFU) derived from plate count methods.

Table 4.17: Yeast and Mold count analysis

Samples	0 hrs	24 hrs	48 hrs	72 hrs
T_0	2	3	4	5
T_1	3	4	3	5
T_2	3	4	4	5
T_3	2	3	4	5
T_4	2	4	3	5
T_5	3	3	4	4
T_6	2	3	3	4
T_7	3	3	3	5
T_8	2	3	4	5
T_9	3	4	4	4
T_{10}	3	3	4	4

Shelf-life modeling using MLP

Using Neurosolutions 5.0 and statistical analysis such as MSE, R^2 and r was carried out. By selecting the model with lowest MSE and higher values of r and R^2. We get the best model predicting the shelf-life for the product. With the MSE value as 0.893 and value of r as 0.871, we get the model with the inputs as Oil and Buckwheat. Thus, predicting that oil and buckwheat affect the shelf-life of product.

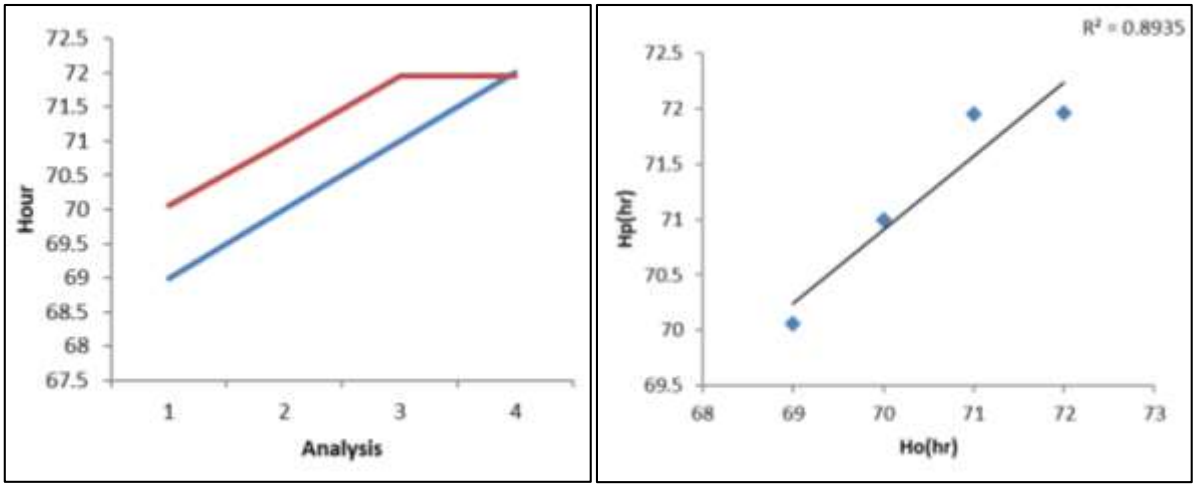

Fig 9: Comparison of observed (H_o) and predicted (H_p) shelf life and corresponding scatter plot in testing MLP-22 (3-2-1) model

Summary and conclusions

Summary

The results summarized were drawn after the present study entitled "Increasing the shelf life of Chapati by value addition" are discussed as follows:

i. Using different variable and balls dough was prepared each weighing 25gm.
ii. The variable such as buckwheat 20%, 30%, 40%, jowar 20%, 30%, 40%; and oil 10%, 15%, 20% were added at three different levels.
iii. The chapatis were prepared by traditional method and then undergo the thermal process for chapati.
iv. The prepared chapatti was stored at 5ºC in refrigerator and then shelf life of chapatti was studied in equal intervals of 24 h for 4 readings.
v. For the 0^{th} h test, no spoilage were found in any sample and the overall acceptability is good rated to buckwheat sample and poor was rated for control sample.
vi. For the 24^{th} h test, no spoilage were found in any sample and the overall acceptability is good rated to buckwheat sample and poor was rated for control sample.
vii. For the 48^{th} h test, no spoilage were found in any sample and the overall acceptability is good rated to buckwheat sample and poor was rated for control sample.
viii. For the 72^{th} h test, no spoilage were found in any sample and the overall acceptability is good rated to buckwheat sample and poor was rated for control sample.
ix. The sensory analysis was done using 9-point hedonic scale and from mean sensory score it was predicted that the hot water sample had significantly superior acceptability as compared to others and control sample had significantly poor acceptability.

Conclusions

The present study revealed that due to application of thermal processing at different time combinations, the microbial stability as well as the sensory, and the texture appearance characteristics of the chapatti using different variables were retained. Chapati which was thermally processed had significantly superior acceptability at 0^{th} h for all variables and it gone decreasing as per the storage time increases. Processed samples were stored at 5 °C for 72 h and tested at each 24 h interval for sensory and microbial tests. At 72 h it was found that all samples were in good condition and showed the overall acceptability good with no microbial spoilage. At the end of the test it was found that buckwheat sample was best accepted while control sample was having poor acceptability. Results from the time measurements and microbiological tests showed that the product was in acceptable condition throughout the storage period.

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