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# Effect of Additives on the Shelf Life Extension of Chapatti

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**A study was designed with the aim to investigate the effect of different additives such as CMC (carboxy methyl cellulose), ascorbic acid, lecithin and sodium propionate on the dough and chapatti making characteristics, and also to check the staling of chapatti. The additives were added at different concentration (CMC 0.5, 0.75 and 1 %, ascorbic acid 0.3, 0.35 and 0.4 %, lecithin 0.5, 0.75 and 1 % and sodium propionate 0.1, 0.2 and 0.3 %) in wheat flour and analyzed their effect on dough rheology along with baking and sensory attributes of chapattis during storage period of 24 h. The results of the present study showed that additives improved the rheological characteristics of wheat flour as compared to control. The additives like CMC and lecithin improved the pasting property, water absorption capacity, dough development time and dough stability of wheat flour. Additives like sodium propionate and ascorbic acid along with CMC and lecithin reduced the mould growth during the storage period of 24 h. The addition of additives improved almost all the sensory attributes as compared to the control.**

Keywords: chapatti, shelf life, additives, CMC, lecithin, sodium propionate

## Introduction

Chapatti is the oldest and the most popular bread in the world (Qarooni, 1990). It is widely consumed all over the world under different names. In Middle Eastern countries it is known as Arabic flat bread and is consumed by 1.8 billion people (Abu-Goush *et al.*, 2002). In South America it is known as tortillas (Cedillo *et al.*, 2004) and in Indo- Pak Subcontinent it is known as Chapatti, Parottha, phulka or roti etc. (Sheikh *et al.*, 2007). The wheat produced in Pakistan is commonly used in the production of chapattis, roti or naan at household and commercial level (Anjum *et al.*, 1993). Chapatti is made form wheat flour or atta and eaten by the majority of population residing in the Indian subcontinent (Rao *et al.*, 1986). Chapatti which is generally consumed in fresh forms is a cheap and primary source of protein and energy (Rehman, *et al.*, 1988) but it has a limited shelf life as if it is not eaten just after cooking it stales quickly and become difficult to chew (Gujral and Pathak, 2002). The two major considerations of short shelf-life of chapatti are microbial spoilage and staling during storage. The adverse changes in chapatti during storage occur due to staling is attributed to retrogradation of the starch component (Rao *et al.*, 1986; Gray and Bemiller, 2003). Staling in chapatti can be controlled by the use of different additives. These include emulsifiers, hydrocolloids, and enzymes. Emulsifiers are commonly added to commercial bakery products to improve their quality and dough handling characteristics. Some frequently used emulsifiers are diacetyl tartaric acid esters of monoglycerides and lecithin (Aust and Doerry, 1992). Similarly the use of surfactants can improve the eating quality of parottha (Indrani and Rao, 2003). Soft texture and better eating quality of stored chapatti can be achieved by the addition of glycerol monosterate along with the sorbic acid and salt (Rao *et al.*, 1986). Another groups of additives extensively used in the baking industry, are the hydrocolloids. These compounds, commonly named gums, are capable of controlling both the rheology and the texture of aqueous systems. Hydrocolloids modify starch gelatinization and extend the overall quality of the product during storage (Rosell *et al.*, 2001).

In Pakistan, most of the work is done to enhance the nutritional value of chapatti by the use of various supplements and very little efforts have been made to improve the eating quality and storage stability of chapatti. Hence, the objective

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**Table 1.** The percentage of different food additives to be used in wheat f lour for preparation of chapatti.

| Additives | Percentage Used | | |
|---|---|---|---|
| **CMC** | $T_1$ 0.5 % | $T_2$ 0.75 % | $T_3$ 1 % |
| **Ascorbic acid** | $T_4$ 0.3 % | $T_5$ 0.35 % | $T_6$ 0 .4% |
| **Lecithin** | $T_7$ 0.5 % | $T_8$ 0.75 % | $T_9$ 1 % |
| **Sodium propionate** | $T_{10}$ 0.1 % | $T_{11}$ 0.2 % | $T_{12}$ 0.3 % |

of present study was to extend the shelf-life and improve the quality of chapatti by the use of different food additives.

## Materials and Methods

*Procurement of Raw Materials* Wheat flour used for this study was obtained by milling AS-2002 wheat variety on China Chakki and the flour was obtained through 100 mesh size sieves. The additives to be used in study like carboxy methyl cellulose (CMC), lecithin, ascorbic acid and sodium propionate were purchased from the local market of Rawalpindi, Pakistan.

*Physical and Chemical Analysis* The chemical analysis of wheat flour with respect to moisture, protein, fat, ash, falling number and gluten was determined according to the AACC (2000). Rheological analysis of the dough in terms of water absorption capacity, dough development time and dough stability was interpreted through Farinogram following the procedure given in AACC (2000). Rheological analysis was conducted at National Institute of Food Science and Technology, University of Agriculture Faisalabad. Chapattis were analyzed for moisture contents after baking according to the AACC (2000).

*Baking of Chapatti* Chapatti dough was made by mixing 200 g of flour with predetermined amount of water for 3 minutes. Different food additives were incorporated in the dough at different levels (Table 1) with slight modifications as mentioned by Sahalini and Laxmi, (2007). The treatments i.e. $T_1$, $T_2$ and $T_3$ are related with CMC, $T_4$, $T_5$ and $T_6$ are related with Ascorbic acid, $T_7$, $T_8$ and $T_9$ are related with Lecithin, whereas $T_{10}$, $T_{11}$ $T_{12}$ represent sodium propionate at different level. Dough was rested for 20 minutes before making dough balls. Sixty five grams of the dough was rounded, rested for 5 minutes and rolled to attain a uniform thickness. Rolled sheet was cut into circular shape having the diameter of 15 cm. The chapatti was cooked on hot plate or tawa and after baking from one side it was turned over and baked from the other side. Chapatti was puffed on open flame for 2 to 3 seconds (Haridas *et al.*, 1986).

*Sensory Evaluation of Chapatti* Chapattis were evaluated for sensory parameters like color, taste, aroma, texture, chewability, foldibilty and over all acceptability according to the method described by Larmond (1997).

*Mold Count* Mould counting in chapatti was made by serial dilution on agar plate technique on sabouraud agar medium (Beneke, 1962). The basic ingredients of media were dextrose 40 g, peptone 10 g and agar 35 g. These ingredients were mixed in 1000 ml distilled water to prepare the media. Sterilization of the media was done in autoclave at 121°C under 15 lbs pressures for 15 minutes and stored in a refrigerator. One g sample of each treatment was taken aseptically and put in dilution bottle and made volume 100 mL by distilled water to prepare 1:100 dilutions. 1 mL of this dilution was poured in the triplicate disposable petri dishes from each sample. 15 mL of molten media was also poured in each. Dilution and media were mixed by swirling the petri dishes to and forth, allowed to solidify and petri dishes were inverted to avoid condensation of moisture inside the cover.

*Statistical Analysis* Data obtained from each parameter was analyzed statistically to assess the significance among various sources of variation using Completely Randomized Design. The differences among the means were compared with Duncan's Multiple Range test (DMRt) as described by Steel *et al.* (1997).

## Results and Discussion

The results of moisture, ash, protein, fat and gluten content are presented in Table 2. The results show that the whole wheat flour contained 13 % moisture, 11.72 % protein, 1.79 % fat, 1.04 % ash, 23.6 % dry gluten and 10.4 % wet gluten. Similar proximate composition of wheat flour has been reported by Sheikh *et al.* (2007).

**Table 2.** Chemical composition of wheat flour.

| Constituents | Percentage ± S.D. |
|---|---|
| Moisture | 13.00 ± 0.26 |
| Ash | 1.04 ± 0.02 |
| Protein | 11.72 ± 0.03 |
| Fat | 1.79 ± 0.01 |
| Wet Gluten | 23.60 ± 0.30 |
| Dry Gluten | 10.40 ± 0.15 |

*All the values are means of three replications.

*Effect of Additives on Dough Rheology* The results of dough rheology are shown in Table 3. It was clear from the results that water absorption of flour was increased with the incorporation of different additives into wheat flour. The highest water absorption was found to be 69.1 % in $T_3$ (1 % CMC) followed by $T_2$ and $T_9$ respectively while the lowest water absorption was found to be 64.1% in control samples. On comparison, it was found that CMC showed the highest water absorption followed by lecithin, sodium propionate and Ascorbic acid.

Furthermore, it was observed that almost all the additives tested increased the water absorption as compared to control. This high water absorption of flour by the use of CMC and lecithin is due to their high water retention capacity. Sahalini and Laxmi (2007) reported the increase in water absorption by the addition of CMC, because it possesses high number of hydroxyl group which allows more hydrogen bonding.

As regarding dough development time it was observed that the highest dough development time was found to be 8.5 min in $T_9$ (1 % lecithin) followed by $T_2$, $T_8$ and $T_1$. While lowest dough development time was found to be 2.90 min with T6 (0.4 % ascorbic acid) followed by $T_5$ and $T_{12}$ (Table 3). Whereas dough development time of control sample was 5.2 min. It is clear from the data that dough development time increased with addition of lecithin and CMC as compared to control, while addition of ascorbic acid and sodium propionate further reduced the dough development time. These results are supported by Berland and Launay (1994), who reported reduced mixing time of dough after the addition of ascorbic acid.

The significantly highest dough stability time was found to be 8.46 min in $T_2$ (0.75 % CMC) with non significant difference with $T_9$. While significantly lowest dough stability time was found to be 4.4 min in $T_{10}$ (0.1 % sodium propionate) with significant difference with $T_0$ (control) and with non significant difference with $T_4$ followed by $T_5$ (Table 3). The comparison of the effect of additives in the present study showed that CMC exhibited the highest dough stability followed by lecithin, ascorbic acid and sodium propionate as compared to control. These results are in accordance with Indrani and Rao (2003) who had also reported increased in dough stability by use of lecithin and CMC.

It was observed from the results that incorporation of additives changed the falling number which indicated changes in viscosity of the system (Table 3). The highest falling number was recorded to be 594 sec. in $T_9$ (1 % lecithin) while the lowest falling number was recorded to be 438 seconds in $T_6$ (0.4 % ascorbic acid). It is evident from the Table 3 that CMC and lecithin increased the viscosity as compared to control. The CMC is hypothesized to compete for water with other components in the dough and increase the viscosity of the wheat flour. Hence the results regarding dough rheology manifest that food additives significantly affect the dough properties and there is dire need to study the interactive effect of food additives on dough rheology and shelf life of chapatti in future.

**Table 3.** Effect of additives on the dough rheology.

| **Treatments** | **Farinographic study** | | | |
|---|---|---|---|---|
| | **Water Absorption (%)** | **Dough development time (min)** | **Dough stability Time (min)** | **Falling number (s)** |
| $T_0$ | 64.01f | 5.20c | 4.50ef | 524f |
| $T_1$ | 67.0de | 8.00ab | 6.16c | 534e |
| $T_2$ | 68.25ab | 8.46a | 8.46a | 554d |
| $T_3$ | 69.1a | 7.33b | 7.33b | 556c |
| $T_4$ | 64.67f | 3.76de | 4.50ef | 484h |
| $T_5$ | 66.5de | 3.33ef | 5.00de | 459i |
| $T_6$ | 66.5de | 2.90f | 6.66bc | 438j |
| $T_7$ | 67.2cde | 7.50b | 6.66bc | 571c |
| $T_8$ | 7.60abcd | 7.83ab | 7.83ab | 581b |
| $T_9$ | 68.2abc | 8.50a | 7.33a | 594a |
| $T_{10}$ | 7.10bcde | 4.40d | 4.40d | 494g |
| $T_{11}$ | 66.6e | 4.06de | 5.33d | 491g |
| $T_{12}$ | 65.8e | 3.66def | 5.50d | 483h |

* Means with a common letter in a column are not significant at 5 % probability level.

*Effect of Additives on Mold Count* It is obvious from the mean values given in Table 4 that with the passage of time mould colonies increased significantly during 24 hours of storage and best treatment is considered to be the one in which mold increase was minimum. The highest mold count was found to be 0.85 × $10^2$/g/mL in $T_0$ (control sample) followed by $T_7$ (0.5 % lecithin), $T_8$ (0.75 % lecithin) and $T_1$ (0.5 % CMC). Whereas least count was observed to be 0.39 × $10^2$/g/mL in $T_{12}$ (0.3 % sodium propionate) followed by $T_{11}$ (0.2 % sodium propionate) and $T_6$ (0.4 % ascorbic acid). The minimum mold count was recorded with $T_{12}$ due to antimicrobial activity of sodium propionate which reduces the water activity. The results are in accordance with Quail (1996), who reported inhibition of mold count by the incorporation of the sodium propionate in wheat flour.

*Moisture Content during storage of Chapatti* The data showed in Table 5 demonstrated that the significantly highest content of moisture were found to be 36.57 % in $T_2$ (0.75 % CMC) with a non significant difference with $T_1$ (0 .5 % CMC). The significantly lowest moisture content was found to be 26.49 % in $T_0$ (control sample) with non significant difference with $T_{11}$. It was found that addition of CMC exhibited highest moisture content followed by lecithin; ascorbic acid and sodium propionate. The moisture content was found to be 33.42 % by the addition of 0.5 % lecithin. It might be due to the reason that lecithin is a surfactant which retains moisture. The data given in Table 6 exhibited the decrease in moisture content of chapattis with the passage of time. These results are in line with the findings of Gujral and Pathak (2002) and Abu Ghoush *et al.* (2002) who reported an increase in moisture content of baked goods with addition of CMC. Similar to CMC, lecithin also increases the moisture content of chapatti.

*Effect of additives on Sensory Evaluation of Chapattis*

**Table 4.** Effect of additives on mold count of chapattis during storage.

| Storage intervals | Treatments | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | $T_6$ | $T_7$ | $T_8$ | $T_9$ | $T_{10}$ | $T_{11}$ | $T_{12}$ |
| **Fresh (100 g per mL of media)** | 0.06c | 0.04c | 0.02c | 0c | 0c | 0c | 0c | 0c | 0.02c | 0c | 0c | 0c | 0c |
| **2 h (100 g per mL of media)** | 0.33b | 0.29b | 0.25b | 0.21b | 0.23b | 0.18b | 0.15b | 0.27b | 0.29b | 0.23b | 0.17b | 0.12b | 0.09b |
| **24 h (100 g per mL of media)** | 0.85a | 0.80a | 0.77a | 0.70a | 0.65a | 0.52a | 0.48a | 0.83a | 0.80a | 0.76a | 0.57a | 0.47a | 0.39a |

* Means with a common letter in a column are not significant at 5 % probability level.

**Table 5.** Effect of additives on the moisture content and sensory evaluation of chapattis.

| Treatments | Moisture | Color | Taste | Aroma | Texture | Chewability | Foldibility | Over all acceptability |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 26.49g | 4.95f | 5.37g | 5.55e | 5.11f | 4.90g | 4.88e | 5.26g |
| $T_1$ | 35.52ab | 6.44c | 6.26bcd | 6.11bcd | 6.10bc | 5.97cd | 6.37ab | 5.83cdef |
| $T_2$ | 36.57a | 6.51b | 6.66ba | 6.32abc | 6.95a | 6.56cb | 6.71a | 6.24bc |
| $T_3$ | 32.87c | 7.17a | 7.13a | 6.73a | 7.09a | 6.67a | 6.75a | 6.40ab |
| $T_4$ | 29.60def | 6.26bcd | 5.46fg | 5.88cde | 5.26ef | 5.37ef | 5.02de | 5.40fg |
| $T_5$ | 31.74cd | 6.37bcd | 5.91def | 6cde | 5.84cd | 5.80de | 5.26cde | 5.51efg |
| $T_6$ | 33.42bc | 6.46bc | 6.11cde | 6.18bcd | 6.11bc | 6.00cd | 5.49cd | 5.55efg |
| $T_7$ | 29.59def | 5.89de | 5.73efg | 5.89cde | 5.75cde | 6.33bc | 6.17ab | 6.20bcd |
| $T_8$ | 30.38def | 6.35bcd | 6.40bc | 6.17bcd | 6.35b | 5.96cd | 6.35ab | 6.59ab |
| $T_9$ | 32.73c | 6.49bc | 6.62b | 6.55ab | 6.83a | 5.54ef | 6.49a | 6.77a |
| $T_{10}$ | 28.87ef | 5.17ef | 5.53fg | 5.78de | 5.33def | 4.86g | 5.17de | 5.42efg |
| $T_{11}$ | 28.24fg | 5.16ef | 5.82defg | 5.83de | 5.55def | 5.08g | 5.51cd | 5.77def |
| $T_{12}$ | 31.12cde | 5.46cde | 6.02cde | 6.22bcd | 5.71cde | 5.42f | 5.82bc | 5.86cde |

* Means with a common letter in a column are not significant at 5 % probability level.

**Table 6.** Effect of storage interval on moisture content and sensory evaluation of chapattis.

| Treatments | Moisture | Color | Taste | Aroma | Texture | Chewability | Foldibility | Over all acceptability |
|---|---|---|---|---|---|---|---|---|
| Fresh | 34.87a | 7.21a | 6.86a | 7.08a | 6.75a | 6.43a | 6.66a | 6.61a |
| 2 h | 31.85b | 6.15b | 6.08b | 6.15b | 6.12b | 5.80b | 5.94b | 6.00b |
| 24 h | 27.23c | 5.15c | 5.29c | 5.28c | 5.12c | 4.96c | 4.94c | 5.11c |

* Means with a common letter in a column are not significant at 5 % probability level.

Comparison of the means of different treatments (Table 5) showed that $T_3$ (1 % CMC) got significantly the highest color scores (7.17) followed by $T_2$ and $T_9$. The significantly lowest color scores were observed to be 4.9 with control sample. Fresh chapatti scored highest for color as compared to stored, while chapattis with added CMC showed whitish color. The color scores were also significantly affected during storage which decreased from 7.21 to 5.15 during 24 hours of storage (Table 6). As regarding taste scores of chapattis, it was observed that with the increment of additives taste scores of chapattis improved. The significantly highest scores for taste was found to be 7.13 in $T_3$ (1 % CMC) followed by $T_2$ and $T_9$. Control samples got the significantly lowest scores (5.37) for taste of chapattis. It is also clear from the data that during storage, chapattis score in terms of taste, decreased from 6.86 to 5.29. The results manifested that both treatments and storage affected the aroma scores of chapattis. The increase in the level of additives increased the aroma scores of chapattis as compared to control sample. The significantly highest aroma scores was found to be 6.73 in $T_3$ (1 % CMC) followed by $T_9$ and $T_8$. Significantly lowest aroma scores was found to be 5.55 with $T_0$ (control samples). During storage, chapattis scores for aroma decreased from 7.08 to 5.28 (Table 6). Similar results were found by Butt *et al.* (2001), who reported increase in aroma by the use of additives like calcium propionate, acetic acid and lactic acid. The texture scores decreased during storage of chapattis while treatments showed improvement in texture scores of chapattis. Significantly highest texture scores were found to be 7.09 in $T_3$ (1 % CMC). The additives might be involved in oxidizing of thiol group of gluten which resulted in better texture of chapattis (Sahalini and Laxmi, 2007). The highest texture scores was observed when chapattis were fresh which decreased from 6.75 to 5.12 during 24 h of storage. It is evident from the results that additions of different types of food additives have shown the improvement towards chewability. Significantly highest chewability scores was found to be 6.67 with $T_3$ (1 % CMC) and the lowest scores (4.9) was recorded in $T_0$ (control samples). During storage, chapattis scores for chewability decreased from 6.43 to 4.96. Among the different additives tested, highest chewability scores were found with the addition of CMC followed by lecithin, ascorbic acid and sodium propionate. The data concerning the foldibility of chapattis showed that increased level of different types of food additives improved towards foldibility of chapattis as compared to the control sample. Significantly highest foldibility scores was found to be 6.75 with $T_3$.

This might be due to the higher moisture absorption capacity of CMC (Sekhon *et al.*, 1980). The maximum foldibility scores were observed when chapattis were fresh which decreased during 24 h of storage from 6.66 to 4.94. Among the different treatments the highest foldibilty scores of chapattis were found with the addition of CMC. Improvement in the chewability and foldability might be due to the addition of CMC and lecithin because both the additives increased the chewiness of chapattis. These results are in accordance to the earlier reserachers (Sekhon *et al.*, 1980; Sahalini and Laxmi, 2007). It is clear from the results shown in Table 5 that over all acceptability scores increased by the addition of increased level of additives. The scores in terms of over all acceptability decreased from 5.26 to 6.77 during storage. Significantly the highest over all acceptability scores was recorded to be 6.77 in $T_9$ (1 % lecithin) followed by $T_8$ and $T_3$. Significantly the lowest over all acceptability scores was found to be 5.26 with $T_0$ (control samples) with non significant difference with $T_{10}$. Chapattis with added lecithin showed the best scores in terms of over all acceptability followed by CMC, sodium propionate and ascorbic acid. Similar results was found by Gill *et al.* (2006), who observed improvement in overall acceptability of chapattis after the addition of lecithin. Both CMC and lecithin improved most of the sensory attributes of chapattis, which might be due to retention of moisture content of chapattis. These results regarding sensory evaluation are in accordance with Rao *et al.* (1986), Indrani and Rao (2003), Sahalini and Laxmi (2007) and Gill *et al.* (2006).

## Conclusion

From the results of present study it can be concluded that 0.75 % of CMC and 1% of lecithin may be used in wheat flour for preparation of chapattis at home scale. However to retard the mold growth ascorbic acid as well as sodium propionate can be very effective. Therefore it is recommended that CMC, lecithin, sodium propionate and ascorbic acid can be used in wheat flour as these extend the shelf life of chapattis and also improve the sensory attributes of chapattis. There is also a need to plan a study on interactive effect of food additives on dough rheology and shelf life of chapatti in future.

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