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# EFFECT OF MODIFIED CEREAL STARCHES ON DOUGH AND BREAD QUALITY

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Modified starches are used as dough improver in different bakery products. In current study, modified cereal starches were exploited as dough improver by incorporating heat moisture treatment, acid hydrolyzed, oxidized, cross linked and octenyl succinic anhydride modified rice and corn starches at the level of 10% in wheat flour. The substituted flours were evaluated for their farinographic properties as well as pasting parameters. The quality of bread prepared from blended flours was examined in terms of bread hardness, volume and sensorial attributes. Rheological behaviour of the substituted dough showed that farinograpic water absorption was increased by addition of octenyl succinic anhydride modified starches while the dough stability was enhanced by cross linked starches. The pasting properties demonstrated highly significant effect of incorporating various modified cereal starches in wheat flour. The bread containing octenyl succinic anhydride modified and cross linked starches had soft texture while heat moisture treatment starches exhibited hard texture during storage. The volume and hardness of bread depicted inverse relationship i.e. soft texture and high volume. All these outcomes epitomize that substitution of modified starches particularly the octenyl succinic anhydride and cross linked starches can improve the quality of bread.

**Keywords:** Modified starches, substituted flour, pasting parameters, farinographic properties, bread

## INTRODUCTION

Starch is a natural constituent of food as well as a multifaceted food additive that is not comparable to any other ingredient employed in the processing industry. As an additive it is commonly used in sauces, puddings, confectionaries along with various baked, dairy and meat products. Alteration in the granular nature of starch molecules has facilitated the innovations in processing techniques as well as in products. The specialty starches with altered functional attributes have been adapted to develop competitive benefits in novel food products, enhance product throughput, consistency and improved product stability (Taggart, 2004). Modification in the granular structure of starch is done through physical, chemical or enzymatic means so as to utilize it in a wide range of eatables with assorted functionalities as native starches are not capable to impede syneresis, retrogradation, cohesive, rubbery and unfavorable gel properties (Whistler and BeMiller, 1997). They are also gaining more attention among health conscious masses because of their slow digestibility. Furthermore, the economical worth of modified starches is comparatively less than other hydrocolloids like gums, stabilizers, etc. (Techawipharat *et al*., 2008).

Various chemical reactions are exploited for the development of modified starches such as conversion (acid hydrolyzed starches, dextrins and oxidized starches), cross linking (distarch phosphate and distarch adipate), esterification (starch acetate, phosphate and succinate) and ether reaction (carboxymethylated starch and hydroxypropylated starch) (Wurzburg, 2006).All these modified starches are employed extensively in snack foods and baked products especially bread and cakes to improve their quality. Bread is one of the largely consumed food product across the globe and starch is the basic constituent in bread making. It imparts a specific character to the texture as well as improves the quality of dough and bread (Miyazaki *et al*., 2006). Modified starches are usually incorporated upto 20% in baked products without any depreciate effect on end product quality. The substitution of modified starches not only effects the rheological and pasting properties of the dough but also control the staling of baked products (Ziobro *et al*., 2012). Antistaling characteristics of modified starches has recently been recognized because they provide unique texture and improve the quality of bread (Miyazaki *et al*., 2008). Staling is the main deterioration factor in bread quality so the addition of modified starches stressed the need to explore the potential of various modified cereal starches as bread improvers. Thus, the present study was intended to appraise the rheological and pasting properties of the wheat flour substituted with various modified rice and corn starches. Furthermore, bread were prepared from the substituted flour and examined for their physicochemical parameters during storage.

## MATERIALS AND METHODS

***Procurement of raw materials*:** Patent flour and the reagents were procured from local market and Merck (Merck KGaA, Darmstadt, Germany), respectively. Rice and corn starches were prepared in the laboratory by following their respective methods as mentioned below;

***Heat moisture treatment (HMT)*:** Rice and corn starches were physically modified by Heat Moisture Treatment according to the method of Hormdok and Noomhorm (2007) at elevated moisture content (30%) and below the gelatinization temperature of starch.

***Acid hydrolysis*:** Acid hydrolyzed starches were prepared by the addition of hydrochloric acid as described by Tavares *et al*. (2007).

***Oxidation*:** Oxidation of rice and corn starches was done by following the protocol of Wang and Wang (2003) using sodium hypochlorite as the functional reagent.

***Cross linking*:** Cross linked starches were prepared according to the method of Woo and Seib (2002) using 10 % (w/w) mixture of sodium trimetaphosphate/sodiumtripolyphosphate (99/1% w/w).

***Octenyl succinic anhydride (OSA) modification*:** Esterification of starch was done by the addition of octenyl succinic anhydride (OSA) to starch slurry according to the method reported by Kim *et al*. (2010).

***Substituted flour development*:** The flour was substituted with different modified starches at 10 % level as depicted in Table1. The substituted flour was analyzed for its rheological characteristic and then utilized in the development of bread so as to evaluate the incorporation of modified starches on dough and bread properties, respectively.

**Table 1. Treatments plan for product development.**

| Treatments | Description |
|---|---|
| $T_0$ | Control |
| $T_1$ | Wheat flour + HMT rice starch |
| $T_2$ | Wheat flour + acid hydrolyzed rice starch |
| $T_3$ | Wheat flour + oxidized rice starch |
| $T_4$ | Wheat flour + cross linked rice starch |
| $T_5$ | Wheat flour + OSA rice starch |
| $T_6$ | Wheat flour + HMT corn starch |
| $T_7$ | Wheat flour + acid hydrolyzed corn starch |
| $T_8$ | Wheat flour + oxidized corn starch |
| $T_9$ | Wheat flour + cross linked corn starch |
| $T_{10}$ | Wheat flour + OSA corn starch |

***Farinographic parameters of substituted dough*:** The physical dough properties of wheat flour blends containing modified cereal starches were determined by using Farinograph (Brabender D-4100 SEW; Germany) according to the procedure described in AACC (2000). The farinograms were interpreted for different characteristics like water absorption, dough development time and dough stability.

***Pasting properties of substituted dough*:** The viscograms of the wheat flour substituted with the modified cereal starches were recorded by following the protocol of Xiao *et al.* (2012) using a Rapid Visco Analyzer RVA-4SA (Newport Scientific Pvt. Ltd., Warriewood, NSW, Australia) interfaced with a personal computer equipped with Thermocline for Windows software.

***Bread making procedure*:** The bread was prepared according to the straight dough procedure outlined by AACC (2000) Method 10-10B. After preparation, the bread was cooled and packed in polythene packages before further analyses.

***Quality evaluation of bread during storage*:** The bread were analyzed for their physicochemical properties during storage at an interval of 0, 24, 48 and 72 hrs.

***Hardness measurement*:** Hardness of bread was performed according to Piga*et al*. (2005) with some modifications using Texture Analyzer (TA-XT2, Plus, Stable Microsystems, Surrey, UK) interfaced with a computer. Bread loaves were sliced mechanically and two slices were stacked together for each test, discarding two end slices of the loaf. A crosshead speed of 10 mm/min with a load cell of 50 kg was used to measure bread hardness during storage.

***Bread loaf volume*:** The loaf volumes were measured using the rapeseed displacement method by following the guidelines of AACC (2000).

***Sensory evaluation*:** The subjective evaluation of bread was carried by trained panel of judges using hedonic scale system according to the protocol of Meilgaard*et al.* (2007). The sensory parameters of bread prepared by constituting modified corn and rice starches were evaluated at Sensory Evaluation Laboratory, NIFSAT, UAF, Faisalabad. The panelists were provided with separate booths with proper lightening. The bread were served in white disposable plates with random coding. The panelists were provided with distill water to cleanse after each test.

***Statistical analysis*:** The resultant data were analyzed through completely randomized design (CRD) by using Cohort version 6.1 (Costat-2003) according to the guidelines of Steel *et al*. (1997). Moreover, analysis of variance (ANOVA) was used to measure the level of significance. The significant difference between means was determined according to Tukeys HSD Teat at 5% probability level.

## RESULTS

***Farinographic properties of substituted dough*:**All the farinographic parameters illustrated momentous differences in water absorption, dough development time and dough stability among all the treatments. It was inferred that water absorption varied from 54.67±1.68% to 59.73±0.81% whilst, the dough development time diverged from 4.37±0.19 min to 6.80±0.02 min with highest value in control ($T_0$) 6.80±0.02 min and lowest in flour blended with cross link corn starch ($T_9$) 4.37±0.19 min, respectively. Means pertaining to the dough stability illustrated a declining trend except cross link starches. Flour containing cross linked rice starch ($T_4$) attained the highest scores of dough stability as 14.01±0.53 min (Table 2).

**Table 2. Effect of treatments on the farinographic characteristics of substituted flour.**

| Treat | Water absorption (%) | Dough development time (min) | Dough stability (min) |
|---|---|---|---|
| $T_0$ | 56.68±1.02b | 6.80±0.02a | 12.38±0.42b |
| $T_1$ | 54.67±1.68d | 6.07±0.15b | 11.39±0.42c |
| $T_2$ | 55.18±0.99cd | 5.32±0.10c | 10.63±0.69d |
| $T_3$ | 55.75±1.64c | 5.71±0.19bc | 10.75±0.45d |
| $T_4$ | 56.15±1.62bc | 4.59± 0.18d | 14.01±0.53a |
| $T_5$ | 59.40±1.17a | 6.23±0.16ab | 11.93±0.28bc |
| $T_6$ | 54.93±1.26d | 6.05±0.09b | 11.31± 0.57c |
| $T_7$ | 55.87±0.91c | 5.59± 0.60c | 10.68±0.64d |
| $T_8$ | 56.37±1.39b | 6.11±0.49ab | 11.02±0.29cd |
| $T_9$ | 55.97±1.40c | 4.37±0.19d | 13.96±0.30a |
| $T_{10}$ | 59.73±0.81a | 6.39±0.31a | 11.30±0.56c |

Values are expressed as means ± standard deviation. Means within columns with different letter are significantly different ($P$< 0.05); $T_0$= Control, $T_1$=Flour containing 10% HMT rice starch, $T_2$=Flour containing 10% acid hydrolyzed rice starch, $T_3$=Flour containing 10% oxidized rice starch, $T_4$=Flour containing 10% cross linked rice starch, $T_5$=Flour containing 10% OSA rice starch, $T_6$=Flour containing 10% HMT corn starch, $T_7$=Flour containing 10% acid hydrolyzed corn starch, $T_8$=Flour containing 10% oxidized corn starch, $T_9$=Flourcontaining 10% cross linked corn starch, $T_{10}$=Flour containing 10% OSA corn starch

***Pasting parameters of substituted flour*:** The effect of blending modified starches in wheat flour demonstrated considerable variations on the pasting properties. Peak viscosity (PV)for composite flours delineated that PV ranged from 1679.73±2.52 cP to 2565.71±2.52 cP. The final viscosity varied from 1733.02±2.01 cP to 2877.75±3.21 cP with the highest value illustrated by $T_{10}$ treatment (wheat flour containing OSA modified corn starch). The lowest value of breakdown was assessed in (wheat flour containing oxidize rice starch) $T_3$ (985.23±1.53 cP) while the highest value was observed in wheat flour substituted with HMT corn starch (1677.37±1.53 cP). Setback varied from 454.23±2.0 cP to 1152.08±2.01 cP. Pasting temperature illustrated substantial variation among all the treatments and the values ranged from 64.77±1.72°C to 67.78±0.85°C (Table 3).

***Hardness of bread*:**Hardness of bread demonstrated substantial effect among all the treatments during storage (Table 4). Bread containing Heat moisture treatment (HMT) starches were harder as compared to all other treatments while OSA modified starches illustrated soft texture; the acid hydrolyzed and cross linked starches depicted intermediate values. The treatments revealed significant variation as a function of storage and the means varied from 2.45±0.03 kg (0 hr) to 3.42±0.05 kg (72 hr).

***Volume of bread*:**All the modified starches affect the volume of bread considerably at 0 hr storage while after 72 hr non-significant effect was found on bread volume. The highest volume was observed in ($T_5$) flour substituted with OSA rice starch trailed by $T_{10}$, $T_0$, $T_7$, $T_3$, $T_2$, $T_9$, $T_4$, $T_8$, $T_1$ and $T_6$ as 695.02±9.05 $cm^3$, 689.25±7.75 $cm^3$, 686.08±6.12 $cm^3$, 676.75±5.79 $cm^3$, 674.0±5.05 $cm^3$, 673.25±7.83 $cm^3$, 671.56±9.25 $cm^3$, 664.38±7.61 $cm^3$, 663.83±6.55 $cm^3$, 587.17±5.98 $cm^3$ and 577.67±9.05 $cm^3$, respectively (Fig. 1).

***Sensory analysis of bread*:**Statistical inference of volume illustrated that it varied from 7.22±0.09 to 7.90±0.11 among all the treatments, the inclusion of modified starches reduced the volume of bread with the lowest value in bread

**Table 3. Effect of treatments on the pasting properties of substituted flour.**

| Treatments | Peakviscosity (cP) | Final viscosity (cP) | Breakdown (cP) | Setback(cP) | Pasting temp (°C) |
|---|---|---|---|---|---|
| $T_0$ | 2086.31±2.52c | 2533.78±2.52c | 1458.13±2.52c | 1022.70±2.52c | 66.67±1.86bc |
| $T_1$ | 1793.06±2.65f | 2065.27±2.51f | 1574.50±2.00b | 1146.00±2.00a | 67.25±0.72b |
| $T_2$ | 1814.75±2.52e | 1947.03±2.00g | 1086.08±2.00h | 1076.30±1.53b | 67.78±0.85a |
| $T_3$ | 1683.69±2.51g | 1726.71±1.53h | 985.23±1.53i | 656.67±2.52f | 64.85±1.38de |
| $T_4$ | 1975.32±3.01d | 2255.47±2.52d | 1256.21±2.00e | 833.00±2.00e | 66.13±0.03c |
| $T_5$ | 2565.71±2.52a | 2862.32±2.52b | 1173.07±2.00f | 454.23±2.00h | 65.60±0.20d |
| $T_6$ | 1798.10±2.01f | 2089.33±1.53e | 1677.37±1.53a | 1152.80±2.01a | 67.58±1.31ab |
| $T_7$ | 1818.09±2.00e | 1959.77±1.52g | 1112.30±2.00g | 1081.00±1.01b | 67.42±1.01ab |
| $T_8$ | 1679.73±2.52g | 1733.08±2.01i | 1028.92±1.52hi | 653.67±1.50f | 64.77±1.72e |
| $T_9$ | 2094.00±1.96b | 2259.06±1.00d | 1289.10±2.02d | 866.00±2.00d | 66.08±0.02c |
| $T_{10}$ | 2560.34±1.87a | 2877.75±3.21a | 1177.50±2.00f | 477.67±2.52g | 65.60±0.20d |

Values are expressed as means ± standard deviation. Means within columns with different letter are significantly different ($P$< 0.05); $T_0$= Control, $T_1$=Flour containing 10% HMT rice starch, $T_2$=Flour containing 10% acid hydrolyzed rice starch, $T_3$=Flour containing 10% oxidized rice starch, $T_4$=Flour containing 10% cross linked rice starch, $T_5$=Flour containing 10% OSA rice starch, $T_6$=Flour containing 10% HMT corn starch, $T_7$=Flour containing 10% acid hydrolyzed corn starch, $T_8$=Flour containing 10% oxidized corn starch, $T_9$=Flourcontaining 10% cross linked corn starch, $T_{10}$=Flour containing 10% OSA corn starch

**Table 4. Effect of modified starches on hardness of bread (kg).**

| Treatments | Storage Intervals (Hrs) | | | | Means |
|---|---|---|---|---|---|
| | 0 | 24 | 48 | 72 | |
| $T_0$ | 2.78±0.05 | 3.03±0.03 | 3.30±0.04 | 3.78±0.02 | 3.22±0.04c |
| $T_1$ | 3.66±0.08 | 3.95±0.04 | 4.28±0.05 | 4.67±0.06 | 4.14±0.06a |
| $T_2$ | 2.32±0.04 | 2.67±0.02 | 2.93±0.02 | 3.23±0.04 | 2.79±0.02d |
| $T_3$ | 2.09±0.03 | 2.36±0.02 | 2.86±0.02 | 3.04±0.03 | 2.59±0.02fg |
| $T_4$ | 1.97±0.01 | 2.18±0.03 | 2.74±0.03 | 3.15±0.03 | 2.51±0.03g |
| $T_5$ | 1.92±0.01 | 2.07±0.01 | 2.43±0.02 | 2.78±0.02 | 2.30±0.02h |
| $T_6$ | 3.47±0.05 | 3.83±0.04 | 4.15±0.05 | 4.58±0.04 | 4.01±0.05b |
| $T_7$ | 2.36±0.02 | 2.73±0.03 | 2.87±0.03 | 3.28±0.03 | 2.81±0.02d |
| $T_8$ | 2.19±0.01 | 2.39±0.02 | 2.99±0.04 | 2.98±0.01 | 2.63±0.01e |
| $T_9$ | 2.23±0.02 | 2.48±0.03 | 2.89±0.03 | 3.29±0.03 | 2.72±0.01de |
| $T_{10}$ | 1.94±0.01 | 2.13±0.01 | 2.57±0.02 | 2.88±0.01 | 2.38±0.02h |
| Means | 2.45±0.03d | 2.71±0.03c | 3.09±0.05b | 3.42±0.05a | |

Values are expressed as means ± standard deviation. Means within columns with different letter are significantly different ($P< 0.05$); $T_0$= Control, $T_1$=Flour containing 10% HMT rice starch, $T_2$=Flour containing 10% acid hydrolyzed rice starch, $T_3$=Flour containing 10% oxidized rice starch, $T_4$=Flour containing 10% cross linked rice starch, $T_5$=Flour containing 10% OSA rice starch, $T_6$=Flour containing 10% HMT corn starch, $T_7$=Flour containing 10% acid hydrolyzed corn starch, $T_8$=Flour containing 10% oxidized corn starch, $T_9$=Flourcontaining 10% cross linked corn starch, $T_{10}$=Flour containing 10% OSA corn starch

**Table 5. Means for the sensorial parameters of bread.**

| Treatments | Volume | Evenness | Crust character | Crumb color | Taste | Texture |
|---|---|---|---|---|---|---|
| $T_0$ | 7.65±0.13a | 7.42±0.05ab | 7.52±0.06 | 7.42±0.02ab | 7.62±0.07 | 7.66±0.04ab |
| $T_1$ | 7.27±0.07d | 7.38±0.03bc | 7.42±0.07 | 6.88±0.03bc | 7.69±0.05 | 6.51±0.02d |
| $T_2$ | 7.55±0.08c | 7.33±0.02c | 7.37±0.04 | 6.93±0.02bc | 7.58±0.03 | 6.88±0.06c |
| $T_3$ | 7.62±0.08bc | 7.27±0.01d | 7.27±0.02 | 7.72±0.04a | 7.63±0.12 | 7.66±0.04ab |
| $T_4$ | 7.84±0.14a | 7.47±0.04a | 7.41±0.03 | 7.35±0.06ab | 7.56±0.08 | 7.69±0.05ab |
| $T_5$ | 7.90±0.11a | 7.42±0.04ab | 7.47±0.04 | 7.86±0.11a | 7.54±0.06 | 7.78±0.03a |
| $T_6$ | 7.22±0.09d | 7.34±0.03c | 7.38±0.04 | 6.78±0.07c | 7.55±0.08 | 6.62±0.02cd |
| $T_7$ | 7.49±0.06c | 7.27±0.02d | 7.32±0.03 | 7.03±0.10bc | 7.65±0.09 | 6.92±0.04c |
| $T_8$ | 7.56±0.07bc | 7.23±0.01d | 7.22±0.02 | 7.77±0.09a | 7.56±0.06 | 7.56±0.07b |
| $T_9$ | 7.77±0.08ab | 7.38±0.03bc | 7.39±0.03 | 7.38±0.06ab | 7.53±0.04 | 7.63±0.06ab |
| $T_{10}$ | 7.89±0.08a | 7.42±0.05ab | 7.44±0.05 | 7.84±0.11a | 7.58±0.11 | 7.62±0.08ab |

Values are expressed as means ± standard deviation. Means within columns with different letter are significantly different ($P< 0.05$); $T_0$= Control, $T_1$=Flour containing 10% HMT rice starch, $T_2$=Flour containing 10% acid hydrolyzed rice starch, $T_3$=Flour containing 10% oxidized rice starch, $T_4$=Flour containing 10% cross linked rice starch, $T_5$=Flour containing 10% OSA rice starch, $T_6$=Flour containing 10% HMT corn starch, $T_7$=Flour containing 10% acid hydrolyzed corn starch, $T_8$=Flour containing 10% oxidized corn starch, $T_9$=Flourcontaining 10% cross linked corn starch, $T_{10}$=Flour containing 10% OSA corn starch

containing heat moisture treatment corn starch (7.22±0.01). Evenness of bread baked by incorporating modified starches was in the range of 7.23±0.01 to 7.47±0.04. Means pertaining to the crumb color exemplify that addition of modified starches enhance the creamish tint of bread. The sensorial scores of the crumb color varied from 6.88±0.03 to 7.86±0.11 among all the treatments. Furthermore, the texture demonstrated significant effect among all the breads as 7.66±0.04, 6.51±0.02, 6.88±0.06, 7.66±0.04, 7.69±0.05, 7.78±0.03, 6.62±0.02, 6.92±0.04, 7.56±0.07, 7.63±0.06 and 7.62±0.08 for $T_0$, $T_1$, $T_2$, $T_3$, $T_4$, $T_5$, $T_6$, $T_7$, $T_8$, $T_9$ and $T_{10}$, correspondingly. The sensorial scores pertaining to the color of crust and taste illustrated non substantial variation among all the treatments (Table 5).

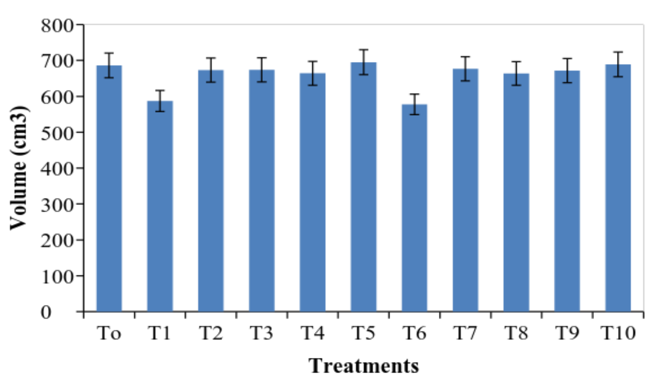


**Figure 1. Effect of modified starches on bread volume ($cm^3$).**

$T_0$= Control, $T_1$=Flour containing 10% HMT rice starch, $T_2$=Flour containing 10% acid hydrolyzed rice starch, $T_3$=Flour containing 10% oxidize rice starch, $T_4$=Flour containing 10% cross link rice starch, $T_5$=Flour containing 10% OSA rice starch, $T_6$=Flour containing 10% HMT corn starch, $T_7$=Flour containing 10% acid hydrolyze corn starch, $T_8$=Flour containing 10% oxidize corn starch, $T_9$=Flourcontaining 10% cross link corn starch, $T_{10}$=Flour containing 10% OSA corn starch

## DISCUSSION

Rheological properties reflect the material behaviour under stress conditions; in bread making, these imitate the influence of flour components as well as other additives (Dobraszczyk and Morgenstern, 2003). The present results are in corroboration with the findings of Miyazaki and Morita (2005), they explored that the substitution of HMT has a declining trend in farinographic parameters of substituted dough. The water absorption reduced from 66.4 to 63.8% while the dough development and dough stability lowered from 6.7 to 5.0 min and 27.5 to 2.5 min, respectively. The water absorption of wheat flour substituted with 15 % high swelling cross linked corn starch was decreased from 61.2 to 59%. While, the pasting profile of substituted wheat flour revealed an increase in peak viscosity and break down viscosity after cross linking but the final viscosity and set back decreased significantly (Hung and Morita, 2004). Accordingly, Miyazaki *et al*. (2005) speculated the effect of substituting three different modified tapioca starches (hydroxypropylated, cross linked and acetylated) on the pasting properties and found that pasting temperature, setback and final viscosity decreased while peak viscosity and breakdown increased in hydroxypropylated starch. All the parameters increased except final and setback viscosity in acetylated starch where as in cross linked tapioca starch substituted flour all the pasting parameters depicted a declining trend. Furthermore, Hadnadev *et al*. (2013) evaluated the effect of OSA modified waxy starch substitution on dough rheological properties by Mixolab. Water absorption increased from 55.4% (control) to 56.1% in wheat flour dough containing 10% OSA starch. Contrary to it, dough development time reduced to 4.96 min in dough having 10% OSA as compare to 5.26 min in 100% wheat flour dough. Dough stability also lowered to 9.24 min in dough with 2.5% OSA. The mechanical parameters of dough are affected by various factors like dilution of gluten, native starch properties and nature of modification process. Increase in water absorption capacity of substituted dough is due to the disrupted granular structure of modified starch as the hydrophobic functional group allow more water to bind (OH) hydroxyl groups via hydrogen bonding (Sweedman *et al*., 2013).

Firmness in bread crumb during storage reflects the process of staling (Seyhun *et al*., 2005). The present findings are in line with the observations of Hadnadev *et al*. (2013) who found that the hardness value of bread produced from flour containing 10% OSA starch (9879 g) exhibited a declining affect as compared to the control bread (14,910 g). Correspondingly, the crumb softening ability of OSA starch is attributed towards its amylose-OSA inclusion complex formation (Thirathumthavorn and Charoenrein, 2006).A study conducted by Miyazaki and coworkers (2005) supported the current findings that incorporation of modified tapioca starches (hydroxypropylated, cross linked and acetylated) in wheat flour affect the texture of bread. The hardness of bread prepared by the addition of modified starches was examined after 72 hrs of storage and findings revealed that bread with hydroxypropylated starch had soft texture with lowest retrogradation and staling rate as compared to the other two starches. The acetylated starch had hardness value similar to control bread while the cross linked starch had higher firmness at 0 hrs. According to Miyazaki and Morita (2005), the incorporation of HMT corn starch increased the firmness of bread during 72 hrs storage. The underlying reason behind increased rate of bread hardness is the disruption of side chains of amylopectin molecules that leach out during thermal treatment and form a hard gel during cooling. After 3 days, firmness value enhanced from 60 $N/m^2$ (control) to 175 $N/m^2$ (bread with HMT starch).

The present findings of bread volume concord with the previous outcomes of Hadnadev *et al*. (2013) who observed the change in bread specific volume by incorporating OSA modified waxy corn starch at 2.5, 5 and 10% levels. The specific volume increased from 2.41 to 2.50 $cm^3/g$ in bread having 10% OSA starch. The increase in volume is due to the fact that OSA modified starches have hydrophobic side chains which increase the interfacial activity during proofing of dough and form gel network during thermal processing. The effect of addition of HMT corn starch on specific volume of bread was assessed by Miyazaki and Morita (2005) and a reduction in volume was observed as the dough elasticity doesn't able to retain air. The control bread had specific volume as 4.2 $cm^3/g$ that lowered to 3.6 $cm^3/g$ when 20% of HMT modified corn starch was substituted with wheat flour. The opacity of bread crumb increase during storage as moisture migrates from crumb to crust. The results regarding the sensory parameters of bread were in accordance to the earlier study; bread prepared by adding 10 % retrograded waxy corn starch. The results revealed that moistness, firmness, taste and over all acceptability of bread improved by the addition of modified starch while the scores of graininess and springiness declined (Hibi, 2001). Furthermore, Uzomah and Ibe (2011) explored the effect of acetylated, oxidized and acid hydrolyzed cassava starch addition at 10% level on the acceptability of bread prepared from the composite flours. The acetylated cassava depicted maximum score (6.58) followed by oxidized (5.57) and acid thinned starches (3.71).

***Conclusion*****:** The substitution of various modified cereal starches improvethe quality of dough and retard staling in bread. It was contemplated that the rheological and pasting properties of the dough were greatly affected by the inclusion of modified starches. HMT reduced the farinographic water absorption while enhanced by OSA addition in wheat flour. Dough development time was reduced by cross linked starches whereas the dough stability was enhanced. The pasting parameters including peak viscosity and final viscosity were increased by OSA starches addition in wheat flour while decreased by other modified starches. Setback and breakdown viscosities enhanced by HMT and reduced by the incorporation of oxidized starches in wheat flour. Hardness of bread containing modified starches was in the increasing order as OSA<cross linked<oxidized<acid hydrolyzed<HMT. Bread containing OSA modified starches had high volume and soft crumb texture among all the modified starches during storage. In general, the results demonstrated that the modified starches have a potential to improve the quality of bread.

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