# Effect of modified starch on some physico-chemical and sensory properties of low fat Hamburger

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**Key words:**
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***Abstract:***

**BACKGROUND:** Fat replacers are ingredients that can replace fat in many foods, therefore,many consumers have limited their dietry intake of fat and calories due to diet and health concerns. **OBJECTIVES:** The present study investigated the effect of modified starch on some physico-chemical and sensory properties of low fat Hamburger. **METHODS:** In this research, modified starch potato, tapioca (Acetylated distarch adipate) and waxy maize (Hydroxypropyl distarch phosphate) at 0.5, 1.5 and 3% levels were used as the fat replacers. The amount of fat was reduced from 20% to 10% in control. Physical (cooking losses), chemical (e.g. moisture, protein, fat, ash) and sensory characteristic were assessed compared with control one. **RESULTS:** Results showed that moisture content in samples containing starch was decreased and there was a significant difference between samples containing starch and the control ($p<0.05$). Among the samples by increasing the amount of starch and reduced added water, the moisture content was decreased. Ash and protein showed no significant difference between starch samples and control. The sensory analysis showed, the panelist group nominated the sample containing 1.5% tapioca modified starch as the best specimen. Cook loss revealed that the cooking losses of the control sample were more than the samples containing starch. **CONCLUSIONS:** This study shows that modified starch can be used successfully as a fat replacer in ground meat product.

## Introduction

Meat and meat products contain elements, which in certain circumstances and in inappropriate proportions have negative effect on human health. (Serdaroglu and Ozsumer, 2003; Jimenez-Colmenero et al., 2001) However, fat is an essential nutrient for the maintenance of life and normal body functions. It is a source of fat-soluble vitamins and essential fatty acids, and constitutes the most concentrated source of energy in the diet. (Turhan et al., 2005; Giese, 1996; Guthrie and Picciano, 1995). Besides the biological and physiological functions, fat plays a maior role in the texture, functional and sensorial properties of comminuted meat product. The other hand, the role of fat as one of the main causes of cardiovascular diseases, cancer has been well documented. (Tokusoglo and Kemal Unal, 2003; Rossum et al., 2000) In recent years, due to increased awareness of consumers and concerns about the relationship between fat and diseases, tendency toward low fat meat products has been increased (Pinero et al., 2008; Carrapiso, 2007; Kumar and Sharma, 2004) but technological aspects associated with the processing of low-fat meat

products inclued problems with texture, flavor and mouthfeel. (Turhan et al., 2005; Crehan, Hughes, Troy and Buckly, 2000) Reducing the fat content, therefore, presents a number of difficulties in term of flavor and texture. Low-fat meat products become firmer, more rubbery, less juicy, darker in color compared to full-fat meat products. However, developing low-fat products while assuring the palatability demanded by consumers is not as simple as just removing the fat. On the other hand, some combinations such as carbohydrates, protein or fat-based replacers could be used to reduce fat content of meat products. (Turhan et al., 2005; Giese, 1996; Egbert et al., 1991) Carbohydrate gums are commonly used by the food industry as texture modifying agents in many different types of products. Starch, the food reserve polysaccharide of plants, is a commonly used food hydrocolloid. Native starches exhibit generally limited resistance towards low pH values in food, the impact of heat during processing and poor performance regarding freeze-thaw stability. Therefore, modification of starch is common practice in order to improve the behaviour of starch towards such processing parameters, freeze-thaw stability. (Feiner, 2006) A number of starches available today are physically and/or chemically modified. (Pietrasik, 1998; Colmenero et al, 1996; Carballo et al., 1995). Modified food starches have been used as binders to maintain juiciness and tenderness in low-fat meat products. (Giese, 1996; Colmenero et al., 1996; Carballo et al., 1995) reported that increased levels of starch favouraly affected cooking loss and purge loss.

## Materials and Methods

Ten different hamburger formulations (Table 1) were prepared. Lean beef were obtained from boneless round and trimmed from all subcutaneous and intermuscular fat as well as thick, visible connective tissue. The lean beef and fat source were ground in a meat grinder (Model CFC, Auto Grind 200). The lean beef (5% fat) and fat were used to formulate lean beef to desired fat levels (10 and 20%). Modified starches were obtained from National starch and Atame Pars Company. The ground lean beef, fat, modified starch, water, onion (30%), salt and spices (2%), rusk flour (8%) were thoroughly mixed in 20kg batches in a grinder mixer (Model WMW 1680 PP2 UAE). Hamburgers were formed using automatic press. The hamburgers were frozen and wrapped with polyethylene film and kept at -18°C until further analysis.

**Proximate of Analyses:** After mixing the hamburger samples were analyzed for percentage of moisture, fat, ash and protein. According to standard AACC (15-44A, 30-10, 08-01, 46-12) procedures using a hot air oven, Soxhelet extraction apparatus, Electric furnace and Kjeldahl assembly respectively. All analyses procedures were repeated in triplicate.

**Cooking losses:** Hamburger samples were thawed at 4°C for 2 h then weighed and were cooked in a pan by oil for 5 min on each side to give an internal temperature of 72±2°C. After 20 min cooling, they were re-weighed and the cooking loss was calculated using the following formula. All cooking measurements were done in three replicates per treatment with slight modifications. (Murphy et al., 1975; Serdaroglu, 2006).

Cooking losses (%) = (uncooked patty weight-cooked patty weight) ×100

**Calorie value:** Total calorie estimates (kcal) for uncooked hamburgers were calculated on the basis of 100g sample. (Turhan et al., 2005; Mansour and Khalil, 1997).

**Sensory analysis:** Sensory analysis was performed by a seven persons in-house taste panel to evaluate the hamburgers for appearances, color, texture, taste, smell, mouth feel by ranking, indicating score 1 as very good and score 5 as very bad (Desmond et al., 1998).

**Statistical analysis:** A randomized complete block design with three replications was used for the experiment. Treatments of three kinds of modified starch,(potato, tapioca and waxy maize) and three levels of modified starch (0.5, 1.5, 3%), were added to hamburgers. Analysis of variance was used to analyze data by One-Way ANOVA. Procedures of the statistical analysis system (SPSS.V.16) were used for data analysis.

## Result

The results of proximate analysis (Table 2) showed that the fat levels of the low-fat products were below the limits (<10% fat) prescribed for low-fat products by Keeton (1994). The fat contents of

Table 1.Hamburger formulations containing modified starch.

| Ingredients | Control(%) | (Low fat hamburger) Treatment contain starch | | |
|---|---|---|---|---|
| | | 1(%) | 2(%) | 3(%) |
| Lean meat | 40 | 40 | 40 | 40 |
| fat | 20 | 10 | 10 | 10 |
| Onion | 30 | 30 | 30 | 30 |
| Salt and spices | 2 | 2 | 2 | 2 |
| Rusk flour | 8 | 8 | 8 | 8 |
| water | - | 9.5 | 8.5 | 7 |
| Modified starch | - | 0.5 | 1.5 | 3 |

Table 2. Proximate composition of hamburgers formulated with different levels of modified starch. Different superscripts in the same column indicate significant differences (p>0.05).

| Treatments | Moisture | Ash | Fat | Protein |
|---|---|---|---|---|
| control | 61.36±0.796$^{a}$ | 2.20±0.065$^{a}$ | 19.92±1.595$^{b}$ | 11.90±0.185$^{a}$ |
| 0.5% potato | 68.64±0.065$^{c}$ | 2.03±0.055$^{a}$ | 9.58±0.285$^{a}$ | 11.87±0.550$^{a}$ |
| 1.5% potato | 68.60±0.045$^{c}$ | 2.02±0.015$^{a}$ | 9.15±0.375$^{a}$ | 12.02±0.675$^{a}$ |
| 3% potato | 66.45±0.100$^{b}$ | 2.02±0.005$^{a}$ | 10.48±0.005$^{a}$ | 11.18±0.100$^{a}$ |
| 0.5% tapioca | 66.09±0.855$^{b}$ | 2.19±0.020$^{a}$ | 9.39±0.225$^{a}$ | 11.08±0.725$^{a}$ |
| 1.5% tapioca | 68.08±0.515b$^{c}$ | 2.18±0.090$^{a}$ | 10.60±0.750$^{a}$ | 10.90±0.165$^{a}$ |
| 3% tapioca | 66.39±0.385$^{b}$ | 2.20±0.045$^{a}$ | 10.58±0.620$^{a}$ | 10.87±0.675$^{a}$ |
| 0.5% waxy maize | 66.65±0.300$^{b}$ | 2.05±0.035$^{a}$ | 10.30±0.160$^{a}$ | 11.23±0.155$^{a}$ |
| 1.5% waxy maize | 66.77±0.950$^{b}$ | 2.05±0.045$^{a}$ | 9.57±0.710$^{a}$ | 11.78±0.115$^{a}$ |
| 3% waxy maize | 62.66±0.270$^{a}$ | 2.82±0.035$^{b}$ | 9.03±0.400$^{a}$ | 11.88±0.160$^{a}$ |

control was %19.13 and ranged between %9.03 and %10.60 for hamburger with added modified starch. Ash contents of hamburgers ranged from %2.02 to %2.20 (p>0.05). (Mansur and.Khalil, 1997; Turhan et al, 2005). The levels of protein were %10.87 to %12.02 in starch samples and control. The moisture content in samples containing starch was decreased and there was a significant difference between samples containing starch and the control. Cook loss revealed that the cooking losses of the control sample were more than the samples containing starch. The calory values for modified starch added hamburgers ranged between 181.29 and 192.54 kcal, the highest calory value (269.04 kcal) were obtained from control sample.

## Discussion

The results of proximate analysis (Table 2) showed that the fat levels of the low-fat products were below the limits(<10% fat) prescribed for low-fat products by Keeton (1994). The fat contents of control was %19.13 and ranged between %9.03 and %10.60 for hamburger with added modified starch. These results closely approximated the targeted fat value of 20% and 10% for control batch and the batch with modified starch added, respectively. Ash contents of hamburgers ranged from %2.02 to %2.20 (p>0.05). (Mansur and.Khalil, 1997; Turhan et al., 2005). Waxy maize modified starch showed significant difference (p<0.05). Although, in the initial analysis of the waxy maize modified starch, the amount of ash was higher (3%).

Protein content was comparable when the low fat and control products were measured because of almost the same amount of lean meat being used in each formulation (Kumar and Sharma, 2004). Protein showed no significant difference between samples and control (p>0.05). The lowest moisture contents of control hamburgers were due to the adjustment of fat to 20%. In samples containing starch, moisture content was decreased compared to control one. (p<0.05) This may be due to the lack of starch and water in control group. Among the samples by increasing the

Table 3.Effect of cooking losses with modified starch. Different superscripts in the same column indicate significant differences (p>0.05).

| Cooking losses | Treatments |
|---|---|
| control | 24.11±4.41$^{d}$ |
| 0.5% potato | 24.06±1.54$^{d}$ |
| 1.5% potato | 16.89±1.60$^{bcd}$ |
| 3% potato | 13.86±3.98$^{abc}$ |
| 0.5% tapioca | 18.01±4.34$^{bcd}$ |
| 1.5% tapioca | 15.99±3.54$^{bcd}$ |
| 3% tapioca | 12.30±2.88$^{ab}$ |
| 0.5% waxy maize | 24.01±0.375$^{d}$ |
| 1.5% waxy maize | 22.94±0.50$^{cd}$ |
| 3% waxy maize | 6.23±0.72$^{a}$ |

Table4. Calorie values of hamburgers with modified starches in 100 gms edible portion.

| Cooking losses | Treatments |
|---|---|
| control | 269 |
| 0.5% potato | 181 |
| 1.5% potato | 185 |
| 3% potato | 192 |
| 0.5% tapioca | 181 |
| 1.5% tapioca | 186 |
| 3% tapioca | 193 |
| 0.5% waxy maize | 181 |
| 1.5% waxy maize | 186 |
| 3% waxy maize | 193 |

Table5. Sensory properties of hamburgers formulated with different levels of modified starch. Different superscripts in the same column indicate significant differences (p>0.05).

| Treatments | appearance | color | texture | taste | smell | mouth feel |
|---|---|---|---|---|---|---|
| control | 2.00±1.00$^{a}$ | 2.33±0.577$^{a}$ | 2.16±1.040$^{a}$ | 2.00±1.00$^{a}$ | 2.16±0.288$^{a}$ | 2.83±0.288$^{a}$ |
| 0.5% potato | 2.50±0.500$^{a}$ | 2.50±0.500$^{a}$ | 2.50±0.500$^{ab}$ | 3.33±0.577$^{a}$ | 3.00±1.00$^{a}$ | 2.50±0.500$^{a}$ |
| 1.5% potato | 3.16±1.040$^{ab}$ | 2.50±0.500$^{a}$ | 3.33±1.154$^{ab}$ | 2.83±0.763$^{a}$ | 2.50±1.32$^{a}$ | 3.00±1.00$^{ab}$ |
| 3% potato | 3.33±1.154$^{ab}$ | 2.50±0.500$^{a}$ | 4.33±1.154$^{ab}$ | 3.16±0.288$^{a}$ | 3.16±0.288$^{a}$ | 3.50±0.500$^{ab}$ |
| 0.5%tapioca | 2.33±0.577$^{a}$ | 2.66±0.577$^{a}$ | 2.00±1.00$^{a}$ | 2.33±0.577$^{a}$ | 2.33±0.577$^{a}$ | 2.00±0.00$^{a}$ |
| 1.5% tapioca | 2.00±1.00$^{a}$ | 2.66±0.577$^{a}$ | 2.00±1.00$^{a}$ | 2.00±0.577$^{a}$ | 2.33±0.577$^{a}$ | 2.33±0.577$^{a}$ |
| 3% tapioca | 2.66±0.577$^{ab}$ | 2.66±0.577$^{a}$ | 4.00±1.00$^{ab}$ | 3.00±0.577$^{a}$ | 2.33±0.577$^{a}$ | 3.33±0.577$^{ab}$ |
| 0.5%waxy maize | 2.33±0.577$^{a}$ | 2.66±0.577$^{a}$ | 2.66±1.154$^{ab}$ | 2.00±1.00$^{a}$ | 3.00±1.00$^{a}$ | 3.66±0.577$^{ab}$ |
| 1.5%waxy maize | 3.33±0.577$^{ab}$ | 2.66±0.577$^{a}$ | 3.66±0.577$^{ab}$ | 3.66±0.577$^{a}$ | 3.66±0.577$^{a}$ | 3.66±0.577$^{ab}$ |
| 3% waxy maize | 5.00±0.001$^{b}$ | 2.66±0.577$^{a}$ | 5.00±0.00$^{b}$ | 4.00±0.288$^{a}$ | 3.66±0.288$^{a}$ | 4.66±0.577$^{b}$ |

amount of starch and decreasing the amount of water, the moisture content was decreased however; the low-fat hamburgers had a moisture content which was significantly higher ($p<0.05$) than the control. (Anderson and Berry, 2001; Crehan et al., 2000; Pietrasik and Duda, 2000; Turhan et al., 2005)

**Cooking losses:** Analysis (Table 3) indicated that cooking losses was significantly decreased ($p<0.05$), by increasing levels of modified starch. This improvement could be due to the increased in moisture binding by added modified starch. Control sample had the highest cooking losses (11,24) because of lack of water and starch in sample. Thus, the more starch added, the less weight was lost during cooking. Inverse relationship between starch and cooking loss were consistent with finding of Pietrasik (1998), also Colmenero et al, (1996) reported decreases in cooking loss during cooking with increasing starch levels. The waxy corn starch riched in amylopectin and also modified starch: Hydroxypropyl distarch phosphate, due to hydrogen bindings caused higher water absorption and lower cooking losses.

**Calorie value:** The highest calory value (269.04 kcal) were obtained from control sample ($p<0.05$). The calory values for modified starch added hamburgers ranged between 181.29 and 192.54 kcal. Incorporation of different amounts of modified starch into the formulations did not affect the colory value of hamburgers ($p<0.05$). Calory reduction with respect to control samples was approximately 30-35%. Because of the targeted fat value of 20% for control batch, and 10% for the modified starch added batch,these results are expected, since fats are the most concentrated dietary calory source, providing 9

kcal,more than twice that supplied by proteins or carbohydrates(Gies,1996; Turhan et al., 2005).

**Sensory Analysis:** Sensory analyses for cooked hamburgers with three types of modified starches containing three different levels are shown in Table 4. By increasing the quantity of modified starch, the sensory panel showed no significant differences ($p>0.05$) in appearance, color, texture, taste, smell and mouth feel. However, treatment including 3% waxy maize, potato and tapioca showed significant differences ($p>0.05$). Meanwhile, it was not accepted by the panelist group.

The significant aspects of this study were that the control and samples containing starch showed no difference, so we could use the modified starch ( as fat replacer) in samples without any changes in appearance, texture, mouth feel, color, etc.

Finally, the sample containing 1.5% tapioca modified starch could be the best prototype.

In conclusion, a number of fat substitutes when added to formulation have the ability to improve low-fat hamburgers. The results showed that incorporation of modified starch improved the cooking characteristics such as cook loss of the low fat hamburger and lowered shear force, due to the ability of these modified starch to retain water and hold it during cooking, but did not cause harmful effects on sensory properties. Hunter lab L*and a* values showed minimal changes with incorporation of hamburgers formulated with modified starch. Since one of the main goals of this scientific research was its practical aspect, the sample containing 1.5% tapioca modified starch could be introduced to the industrial meat products plants as a new healthy product.

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مجله طب دامی ایران، ۱۳۹۱، دوره ۶، شماره ۲، ۹۴-۸۹

# اثر نشاسته اصلاح شده بر برخی از ویژگی‌های فیزیکوشیمیایی و حسی همبرگر کم چرب

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## چکیده

**زمینه مطالعه:** جایگزین های چربی عناصری هستند که می توانند به عنوان جانشین چربی در بسیاری از مواد غذایی بکار برده شوند، بنابراین مصرف کنندگان بر مبنای ملاحظات سلامتی و برنامه های رژیم غذایی شان مصرف چربی وکالری را در رژیم غذایی روزانه شان کنترل می کنند. **هدف:** هدف از این تحقیق بررسی اثر نشاسته اصلاح شده بر برخی از ویژگی های فیزیکوشیمیایی و حسی همبرگر کم چرب می باشد. **روش‌کار:** در این تحقیق از نشاسته های تغییر یافته سیب زمینی، تاپیوکا و ذرت مومی با مقادیر ۰/۵، ۱/۵ و ۳٪ به عنوان جایگزین چربی استفاده گردید و میزان چربی از ۲۰٪ در نمونه شاهد به ۱۰٪ تقلیل یافت. ویژگی های فیزیکی (افت پخت)، شیمیایی (رطوبت، پروتئین، چربی، خاکستر)، و حسی در مقایسه با شاهد بررسی گردید. **نتایج:** نتایج آزمون شیمیایی نشان داد که مقدار رطوبت در تیمارهای حاوی نشاسته نسبت به نمونه شاهد به‌طور معنی داری ($p<۰/۰۵$) افزایش یافت، اما در بین تیمارها با افزایش میزان نشاسته و کاهش آب اضافه شده در فرمولاسیون محتوای رطوبت کاهش یافت. میزان خاکستر و پروتئین بین نمونه شاهد و تیمارها اختلاف معنی داری نداشت. گروه ارزیاب در ارزیابی حسی تیمار ۱/۵٪ نشاسته تغییر یافته تاپیوکا را به عنوان بهترین نمونه معرفی کردند. نتایج افت پخت نشان داد که میزان افت پخت شاهد از تیمارهای حاوی نشاسته بیشتر بود. **نتیجه‌گیری نهایی:** این مطالعه نشان داد که نشاسته اصلاح شده می تواند به طور اثربخش به عنوان جایگزین چربی در فرآورده‌های گوشتی استفاده گردد.

**واژه‌های کلیدی:** فرآورده گوشتی، همبرگر، کم چرب، نشاسته، نشاسته تغییر یافته.

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