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EFFECT OF RICE STARCH AND WASTE PRODUCT OF TOMATO PROCESSING ON SOME PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF SAUSAGE

Mitra PARSI[1], S. Ebrahim HOSSEINI[*2], S. Mahdi SEYEDEIN[3], H. BEHMADI[4]
[1]Department of Food Science and Technology Collage Agriculture and Natural Resource, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran. Phone:021-88444499 Email:mi.parsi@yahoo.com
[2]Department of Food Science and Technology Collage Agriculture and Natural Resource, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran. Phone:021 44865464, Email: Ebhoseini@srbiau.ac.ir
[3]Department of Food Science and Technology Collage Agriculture and Natural Resource, Tehran Science and Research Branch, Islamic Azad University, Tehran, Iran. Email: mahdi_seyedain@yahoo.com
[4]Department of Food Engineering and Post-Harvest Technology, Agricultural Engineering Research Institute, Karaj, Iran. Email: hbehmadi@yahoo.com

Corresponding author email: Ebhoseini@srbiau.ac.ir

Abstract

The producing low-calorie products is an important issue in this industrial world to reduce different diseases. This includes low-calorie meat products because they have a specific place in daily usage. The rice starch and waste product of tomato processing used in this formulation, as fat replacements, were (0.5, 1, 1.5, 2, and 2.5%) and (1, 2, 3, 4, and 5%) respectively. Fat reduced from 21.09% in control to 9.8%. The physical properties (texture), chemical properties (moisture, protein, fat, and ash content), sensory properties, and caloric value were evaluated in produced samples. Results obtained from chemical tests showed that moisture, ash, and protein content increased in treatments containing rice starch and tomato waste powder compared with the control. The results from caloric tests illuminated that the calorie of the samples significantly reduced coincide with fat reduction. The texture analysis tests indicated that all samples were firmer than the control. The sample containing 1.5% rice starch and 3% tomato waste powder had the highest shear stress compared with other samples. The colorimetric tests showed that fat replacing with tomato waste powder and rice starch led to an increase in yellowness (b) and redness (a*) and a decrease in lightness (L*) in samples. According to organoleptic properties, all samples got higher score than the control. However, the sample containing 2% rice starch and 4% tomato waste powder was recognized as the best one. The panellists reported that adding tomato waste powder and rice starch not only didn't have negative effects on sensory properties but also they increased total acceptability. Therefore, considering the results obtained from instrumental and sensory analysis, using tomato waste powder and rice starch respectively 4% and 2% resulted in desirable consequences in fat reduction.*

Keywords: *fat replacement, low-fat sausage, organoleptic analysis, rice starch, powder of tomato waste*

INTRODUCTION

Epidemiological studies have shown that there is a direct relationship between diet (high fat products) and occurrence of some diseases like colon cancer, obesity, and cardiovascular diseases. Like other countries, cardiovascular disease is widespread in Iran which is the cause of 40% of mortality. Since the most important factor is kind and amount of used fat, this has led to rapid changes in eating habits. Therefore, one of the controversial issues in today industrial word is producing low-fat (low-calorie) products containing low-fat meat products. Different researches have been done on low-fat sausages using fat replacers.

Many studies have suggested using tomato waste, tomato powder, tomato peels and lycopene in raw meat and meat products such as beef patties (Sanchez-Escalante et al., 2003), minced meat (Østerlie and Lerfall, 2005), hamburgers (García et al., 2009), fermented sausages (Calvo et al., 2008), fresh sausages (Mercadante et al., 2010) and frankfurters (Deda et al., 2011).

In this study, two fat replacers based on rice starch (has fat like properties) and waste product of tomato processing (fibre) were used

in order to improve the customer acceptability. Significant part (more than 60%) of tomato is used in manufacturing industries leading to a huge waste product. According to previous researches, the tomato waste product in Iran is more than 1.5×10^5 tone (Aghajanzadeh-Golshani et al., 2010). Despite having high bioactive compounds and nutritional value, most of this waste product is dumped and just a limited amount is used to feed livestock and poultries while this can be considered a by-product in tomato industries leading to high investment and new products.

The purpose of this paper is to use of rice starch and tomato waste powder as fat replacers in sausage formulation and study their effect on chemical, physical, sensory, and caloric value of the sausage.

MATERIALS AND METHODS

The tomato waste powder was dried using vaccume oven (Enretvts-70, Germany) in 55°C for 72 h to reach 12.5% of moisture content. It was then milled using a miller (Retsch-Rhcimische-36-D-4278-Haa, Germany).

The obtained powder was sieved with a 40-mesh sieve, packaged in polyethylen bags, and stored in -18°C.

The lean beef was obtained from boneless round and trimmed from all subcutaneous and inter muscular fat as well as thick, visible connective tissue and maintained frozen (0-18˚C). Fat content of the lean meat and fat portions were determined prior to the manufacture of sausages. Rice starch was obtained from National starch and Atame Pars Company. The tomato processing wastes were obtained from Ataco Co. for Food Processing. The control sausages were formulated to contain 60% lean beef with 15% kidney fat. Different levels of vegetable oil (12.5, 10, 7.5, 5, 2.5 and 0%) were replaced by rice starch/tomato waste combinations at different ratios (Table 1). Then, the beef was ground through a 3 mm plate electric grinder (Sky sunPSE-10). Then, the powder of waste product of tomato processing was added to the ground meat and mixed until a homogeneous distribution was obtained. The ingredients of each formulation were weighted (Table 1) and transferred into a cutter (Muller, Saarbrucken, W. Germany) using low speed (1400 rpm). When chopping resulted in a homogenized mixture, garlic, salt, phosphate, nitrate, rice starch and ice was added and chopping continued for 2-3 min with a speed of 2000 rpm. Other ingredients were mixed using a mixer for 3 min at 4-6°C. After mixing, the mixtures were stuffed in to synthetic cellulose casings (approximate diameter of 30mm) using a stuffer (H15, TALSA, Zaragoza, Spain). The farsh was chilled and stored for 1 hour at 0°C to achieve a better filling. The samples were then heated in 72±2°C for 30 min in a steam chamber (SAA10, Absury, Berlin, Germany). The cooked meat batters were cooled with cold water (15°C) and stored at 0-4°C. All analyses were carried out in triplicate for each formulation.

The proximate composition of the sausages samples was determined according to the AOAC standard methods (2011).

Total caloric values (kcal) were calculated using method of Watt and Mersil **(**1975**)**, where 4.27 kcal for g protein and 9.02 kcal for g lipid and 4.10 kcal for g carbohydrate.

Shear force values of raw samples were determined using a computer controlled Hounsfield H5KS Universal testing machine existed in Agricultural Engineering Research Institute. The samples of 5 cm thickness were prepared from central part of each sausage and texture resistance to shear stress was measured using stainless steel flat blade at zero temperature. The colour of the samples was measured using a colorimeter (Minolta spectrophotometer CM 3500d, Japan) and the colour reading included lightness (L*), redness (a*) and yellowness (b*).

The sensory analysis was performed by 10 trained panellists to evaluate the sausages for appearance, colour, texture, taste, smell, mouth feel by ranking, indicating score 0 as very bad and score 5 as excellent (Desmond et al., 1998).

Data were analyzed using SPSS 16.0 for one-way ANOVA. Duncan's new multiple range tests was used to resolve the difference among treatment means. A value of $p<0.05$ was used to indicate significant difference.

RESULTS AND DISCUSSIONS

Table 2 shows the chemical composition of sausages formulated with rice starch/tomato waste combinations.

Table 1. Sausages formulation containing of rice starch and powder of tomato waste

Ingredients	Control (%)	Treatments				
		T1	T2	T3	T4	T5
Lean meat	60%	60%	60%	60%	60%	60%
Oil	12.5	10	7.5	5	2.5	0
powder of tomato waste	0	1	2	3	4	5
Rice starch	0	0.5	1	1.5	2	2.5

Table 2. Proximate composition and calorie content of sausages formulated with different levels of rice starch and powder of tomato waste

Parameters	Control	Treatments				
		T1	T2	T3	T4	T5
Lipid (g/100g)	21.09 ± 3.12^{a}	18.75 ± 2.87^{b}	14.73 ± 2.14^{c}	11.1 ± 1.87^{d}	10.50 ± 1.20^{e}	9.8 ± 10.2^{f}
Moisture (g/100g)	57.8 ± 5.12^{e}	59.20 ± 6.35^{d}	62.24 ± 5.41^{c}	65.60 ± 6.23^{a}	65.50 ± 7.21^{b}	64.46 ± 6.1^{b}
Protein (g/100g)	15.45 ± 3.11^{e}	15.77 ± 2.26^{d}	16.06 ± 2.45^{c}	16.20 ± 2.31^{c}	16.80 ± 1.01^{b}	17.4 ± 1.01^{a}
Ash (g/100g)	2.16 ± 0.20^{d}	2.44 ± 0.31^{c}	2.47 ± 0.34^{bc}	2.50 ± 0.12^{bc}	2.57 ± 0.45^{ab}	2.62 ± 0.98^{a}
Energy (kcal/100g)	645.9 ± 12.31^{a}	570.6 ± 10.21^{b}	509.8 ± 11.41^{c}	2.50 ± 0.12^{bc}	2.57 ± 0.45^{ab}	2.62 ± 0.98^{a}

Different superscripts in the same column indicate significant differences ($p<0.05$).

Table 3. Shear force of sausages formulated with different levels of rice starch and powder of tomato waste

Parameters	Control	Treatments				
		T1	T2	T3	T4	T5
Shear Force (N)	17.08 ± 3.14^{f}	18.10 ± 3.65^{e}	19.20 ± 2.7^{d}	21.45 ± 2.14^{a}	20.93 ± 3.24^{b}	20.11 ± 2.56^{c}

Different superscripts in the same column indicate significant differences ($p<0.05$)

The fat content significantly decreased ($p< 0.05$) in all samples compared with control which is because of reduction of fat content in formulations. Fat content of the control was 21.09. It was decreased to 18.57, 14.73, 11.1, 10.50, and 9.8 in treatments 1, 2, 3, 4, and 5 respectively. Fat reduction was respectively 11.94%, 47.36%, 50.21%, and 53.53% of total fat in final product. The moisture content significantly increased compared to the control ($p<0.05$). The increase in moisture is due to reduction in fat and replacing it starch and fiber (tomato waste powder). Caceres et al. (2006) reported that low-fat frankfurters (40% fat content) had higher moisture content (68%) compared to the control (56%). There was a significant difference in protein and ash content ($p<0.05$) between samples and the control. All samples had higher protein and ash content which was due to higher amount of protein and ash in tomato waste powder.

Table 2 shows that amount of calorie significantly reduced in all treatments compared with the control ($p<0.05$). Amount of calorie evaluated in the control was 645.9 kcal/100 g which reduced to 570.6 kcal/100 g, 509.8 kcal/100 g, 478.4 kcal/100 g, 460.6 kcal/100 g, and 444.8 kcal/100 g in samples 1, 2, 3, 4, and 5 respectively.

The fat reduction and fibre addition resulted in a significant increase in shear force of all samples (Table 3). In other words, texture of the sausages was harder and more compact. Fat content has a key role in the quality of a meat product. Researchers have found that there is a strong relationship between fat content and firmness of the sausages in a way that fat reduction leads to harder texture (García et al., 2009). Moreover, being absorbed part of available moisture for meat proteins by non meat ingredients cause a harder product. The increase of hardness could be explained by the presence of fibre in tomato by-product. It has been reported by Knoblich et al. (2005) which has acid detergent fibre content close to 30 g/100 g of dry matter.

Table 4. Lightness (*L**), redness (*a**) and yellowness (+*b**) values for beef patties formulated with different levels of rice starch and powder of tomato waste

Parameters	Control	Treatments				
		T1	T2	T3	T4	T5
L*	51/14±4/21[a]	51/03±3/65[a]	50/90±2/45[a]	50/68±3/12[a]	49/92±4/11[b]	48/42±3/15[c]
a*	13/03±3/41[c]	13/35±2/42[e]	14/59±2/75[d]	16/74±1/56[c]	18/03±2/75[b]	18/98±2/15[a]
b*	12.65±1.38[d]	13.091±.89[d]	14.06±.3.14[c]	14.49±1.98[b]	15.60±2.54[a]	15.63±2.13[a]

Different superscripts in the same column indicate significant differences ($p<0.05$).

Table 5. Sensory properties of sausages formulated with different levels of rice starch and powder of tomato waste

Parameters	Control	Treatments				
		T1	T2	T3	T4	T5
Flavor	3.04±0.33[d]	3.09±0.54[d]	3.62±0.97[a]	3.65±0.29[c]	4.41± 0.67[b]	4.93±0.98[a]
Color	2. 81±0.53[e]	3.50±0.72[b]	3.49±0.35[b]	4.95±0.94[a]	4.96±0.73[a]	4.23±0.88[b]
Texture	4.69±0.96[a]	3.14±0.32[c]	3.09±0.85[c]	3.10±0.66[d]	3.11±0.31[c]	3.11±0.87[c]
Mouth feel	3.78±0.82[b]	3.75±0.81[a]	3.68±0.52[a]	4.01±0.58[b]	4.57±0.68[b]	4.54±0.69[a]
Acceptability	3.11±0.84[c]	3.08±0.43[d]	3.60±0.22[a]	4.01±0.97[b]	4.82±0.69[a]	4.06±0.83[b]

Different superscripts in the same column indicate significant differences ($p<0.05$).

Adding different amounts of tomato waste powder and rice starch parallel to fat reduction significantly increased b^* and a^* in samples 2, 3, 4, and 5 ($p<0.05$) (Table 4). Because of the addition of lycopene to meat products, through the addition of tomato peel and tomato waste, yellow color increased providing an orange tone (Calvo et al., 2008). The addition of tomato waste powder and rice starch did not affect lightness or darkness of samples 1, 2, and 3, but significantly reduced L^* (lightness) in sample 4 and 5 ($p<0.05$).

The sensory evaluation showed that the fat replacing with different amounts of tomato waste powder and rice starch did not have any unfavourable effects on color, flavour, mouth feel, and total acceptability (Table 5). In contrast, according to the panellists, control got the highest score in texture. Eyiler and Oztan (2011) reported that addition of tomato powder increased the acceptability of the frankfurters. Finally, the sample 4 containing 2% modified rice starch and 4% tomato waste powder was reported as the best sample by the panellists.

CONCLUSIONS

The results obtained from chemical tests showed that moisture, ash, and protein content increased in treatments containing rice starch and tomato waste powder compared with the control.

The results from caloric tests illuminated that the calorie of the samples significantly reduced coincide with fat reduction.

The texture analysis tests indicated that all samples were firmer than the control. Sample containing 1.5% rice starch and 3% tomato waste powder had the highest shear stress compared with other samples.

The colorimetric tests showed that fat replacing with tomato waste powder and rice starch led to an increase in yellowness (b*) and redness (a*) and a decrease in lightness (L*) in samples.

According to organoleptic properties, all samples got higher score than the control. However, the sample containing 2% rice starch and 4% tomato waste powder was recognized as the best one.

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