EFFECT OF GARLIC ON THE PHYSICOCHEMICAL PROPERTIES OF THE PORK PATTIES

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Abstract – The influence of addition of garlic slurry on the physic-chemical properties of pork patties was studied. The pork patties were prepared with ground pork added with sodium chloride (1.5% by weight) as the control, then mixed with 1%, 2% and 3% of garlic slurry as the treatments, respectively. Then all the samples were filled in petri dish and placed on the wire frame in water bath above water surface, and heated to 80°C **for 20 min. and cooled to room temperature for testing. The rheological properties, sulhydryl group content (-SH group), thermal stability of protein and cooking loss of the samples are analyzed. The results were found as follows: The addition of garlic slurry can increase the hardness and chewiness of the patties, and the appropriate usage of garlic can get the highest springiness. The cooking loss was found to increase with an increase in the usage of garlic slurry. Application of garlic slurry can significantly reduce SH group content of the patties and increase the thermal stability of muscle protein. These results indicated that the garlic can be and useful tool to improve the functional properties of meat patties except its antimicrobial, antioxidative effectiveness and health functionality.**

Key Words – rheological properties, sulhydryl group, thermal stability

I. INTRODUCTION

Garlic (*Allium sativum L.*), *Liliaceae Allium*, originating in the west and central Asia area, are distributed around the world. Garlic is considered one of the best healthy foods as providing many functional properties such as antimicrobial, antioxidative, and anticancer effects and food flavoring. However, there are no many studies related meat texture improvement and thermal stability of protein reported. Accordingly, the objective of the present study was to investigate the effects of garlic on the oxidative stability and texture of pork patties, which were evaluated by cooking loss, rheological properties, protein thiols loss and correlated with the degree of protein cross-linking, and the observed effects were discussed in relation to the content of the garlic.

II. MATERIALS AND METHODS

The pork patties were prepared with ground pork loin added with sodium chloride (1.5% by weight) as the control, then mixed with 1%, 2% and 3% of garlic slurry as the treatments, respectively. Then all the samples were filled in petri dish and p laced on the wire frame in water bath above water surface, and heated to 85°C for 20 min. and cooled to room temperature for testing. Cooking loss (%) was calculated as wt (g) of sample before heated – wt (g) of sample after heated/wt (g) of sample before heated x100% (n=3). The texture profile of pork patties was determined using a texture analyzer (TA-XT Plus, SMS, UK), the measurement was replicated for 6 times (n=6). Rheological properties were measured by a rheometer MCR101 with a parallel plate sensor (diameter 50 mm). Samples were heated from 25 to 90°C (2°C/min), and then cooled from 90 to 25°C (5°C/min) that were used to determine the storage modulus and loss modulus. The SH group content was determined according to Ellman [1] method The samples for testing were treated using the procedure modified by Benjakul *et al.* [2] and measured its absorbance at 412 nm using a UV-1800 spectrophotometer (Shimazu, Japan). The final results were expressed in moles of SH per milligram protein (A molar extinction coefficient is 1.36x104 M-1cm-1 was used). The analytical software SPSS 13.0 was used to perform analysis of variance and Duncan's test. The differences between treatments were verified by their least significant difference.

III.	RESULTS AND DISCUSSION

Cooking loss was found to be significantly higher in pork patties added 3% garlic, while it was not found significant difference between addition of 1% and 2% garlic and the control. The cooking loss was shown to decrease with an increase in the garlic usage. This result might be attributed to sulfhydryl groups oxidized to disulfides to impair pork binding water capacity, which agreed with the effect of polyphenols in green tea extract on WHC of meat emulsion properties reported by Jongberg *et al.* [3]. The presence of 3% garlic in the pork patties was found to increase cooking loss, indicating that the stability of the three-dimensional network had been jeopardized.

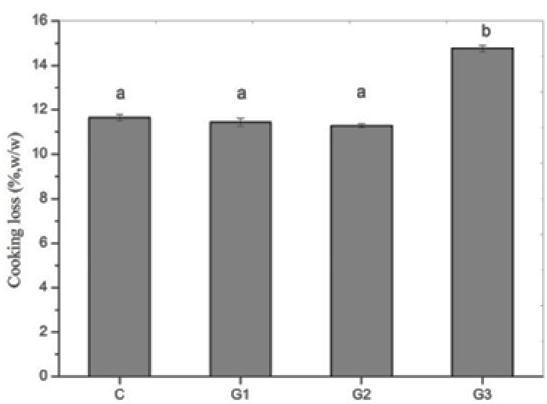

Figure 1. Cooking loss (%, w/w) in patties added 1% garlic (G1), 2% (G2), 3% (G3), and control patties without any addition. Letters (a, b) denote significant difference (P<0.05) between treatments.

The textural properties of the pork patties were evaluated by three parameters (Table 1): Hardness, chewiness, and springiness. Hardness represents the force needed to break the pork patties, and chewiness is used to describe the nature of the samples that were chewed, which reflect required energy from chewable state to swallowable state. Springiness represents the extent of that sample after the first compression can be restored. Both hardness and chewiness were found to be significantly higher in pork patties added garlic as compared to the control (Table 1). The effect of garlic on the springiness of the pork patties was less apparent between C, G1, and G3. Both hardness and chewiness tended to be increased by increasing concentrations of garlic. In general, garlic was found to be higher hardness, chewiness, and springiness of the pork patties in a usage-dependent manner, indicating that the garlic altered the gel-forming ability of the pork proteins. The proper amount of concentration of garlic will react with the protein thiols, which promotes the proteins from generating the stabilizing disulfide bonds. However, high concentration of garlic (>3%) may result in a poor protein network, and consequently, the water holding capacity drops, and the textural properties become stiffen.

Table 1. Comparison on the difference in rheological properties of pork patties between the control and garlic added*.

Treatments	Hardness (g)	Chewiness (g)	Springiness
C	2964.576±4.2a	2048.59±2.6a	0.866±0.01b
G1	3301.643±4.2b	2258.737±4.0b	0.859±0.03b
G2	3641.155±6.6c	2525.212±4.9c	0.877±0.04a
G3	4289.755±6.5d	2953.919±4.4d	0.868±0.03b

*1. C=the control, G1=1% garlic, G2=2% garlic and G3=3% garlic addition.
2. Mean ± sd of data are presented.
3. Letters (a-d) denote significant differences (P<0.05) between different treatments.

The effects of garlic on the rheological properties of pork during heating and cooling are shown in Fig. 2. During the heating stage (Fig. 2a), the pork exhibited a complex rheological pattern during the heating from 25 to 90°C. The G′ of the samples started to decrease at about 48°C then showed a G′ trough at 54°C followed by a continuous increase towards 85°C and showing a G′ peak at 80°C. This may be due to that the denaturation of protein was related to the increase of G′ for molecules loosely unfold and expose their active groups, enabling crosslinking to happen, thus enhanced gel hardness. The rheological pattern exhibited similar changes in G′ despite the differences in magnitude. The values of G’ was also usage-dependent. And the magnitude of G′ added 1% garlic and 2% garlic at the peak was increased by about 55% compared with the fresh and G3. Meanwhile, G1 and G2 showed no changes in the onset temperature of G′ peak. The reduction in G′of the G3 might result from alterations in the functional groups of myofibrillar proteins. Moreover, it could be due to the disulfide-bond formation. The physicochemical changes might facilitate strengthening the gel network during thermal gelation [4] while the formation of large protein aggregates, which may hinder ordered interactions of reactive functional groups, had a negative effect on G′. It was interesting that the G′at the end of heating decreased with the increasing addition of garlic. Compared with the control, addition of garlic between G1 and G2 led to a slight decrease in G′ at the end of heating.

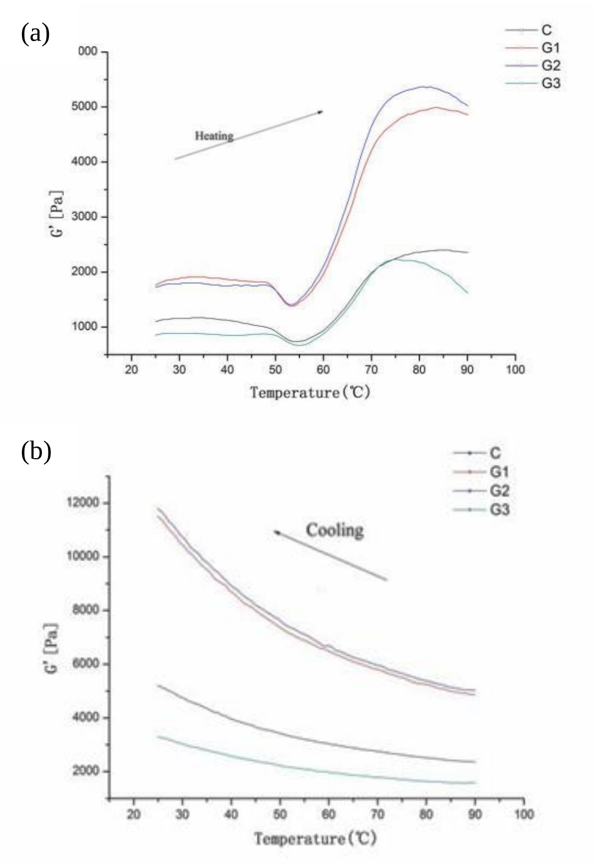

Figure 2. Influence of different concentrations of garlic on storage modulus (G′) of pork during heating (a) and cooling (b) stage of thermal gelation. C-Control; G1-1% Garlic; G2-2% Garlic; G3-3% Garlic.

During the cooling phase (Fig. 2b), the G′of all samples gradually increased, suggesting that continued cross-linking occurred among protein molecules. And the slope of the ones added 1% garlic and 2% appeared much more steep.

Total sulfhydryl group content (total SH) and Surface active thiol group content are shown in Fig. 3. The continuous decrease in total SH content was observed in all samples. Decreases in total SH content were concomitant with the decreased Surface active thiol group content. The total sulfhydryl group content of unheated patties were higher than the total sulfhydryl group content of heated patties. The surface active thiol group content exhibited similar changes in unheated and heated patties. During heating, the formation of disulfide bond might be induced and involved in aggregation (Fig. 3). This indicated that thermally exposed sulfhydryl groups could be oxidized to disulfide bond, especially at temperature above 40°C. A decrease in total SH groups was reported to be due to the formation of disulfide bond through oxidation of SH group or disulfide interchanges [5]. Addition of garlic was found to have a significant effect on the thiol concentration, and G3 levels were found to be on average 8% lower than in the control pork patties.

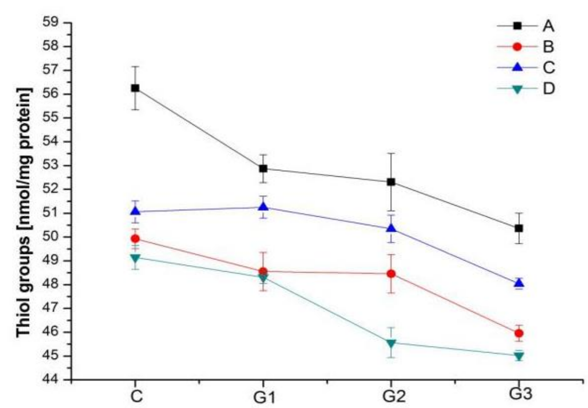

Figure 3. Protein thiol groups (nmol/mg protein) in pork patties added 1% garlic (G1), 2% garlic (G2), 3% garlic (G3), and the control patties without garlic. Bars represent standard deviation from triplicate determinations.

A- Total sulfhydryl group content of unheated patties;

B- Surface active thiol group content of unheated patties;

C- Total sulfhydryl group content of heated patties;

D- Surface active thiol group content of heated patties.

IV. CONCLUSION

In conclusion, application of garlic in pork resulted in improvement of the rheological properties of the pork patties. The garlic of 2% (w/w) added pork patties showed the highest springiness and the storage modulus was 55% higher compared with the control and G3. Further, the addition of garlic should also improve the hardness and chewiness of the patties. When the garlic applied to pork, it did not present a great impact on the moisture content. In this study, adding 2% garlic was estimated as the optimum value. The garlic can be a useful tool as a cross-linking agent of pork patties to improve the functional properties if the optimum dose of garlic is determined prior to an application.

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