EFFECT OF RESISTANT CORN STARCH ON THE THERMAL GELLING PROPERTIES OF CHICKEN BREAST MYOSIN

Xi-xi Wang, Yue-shuang Li, Ying Zhou, Pei-jun Li, Fei Ma *, and Cong-gui Chen *

School of Food Science and Engineering, Hefei University of Technology, Anhui province, People's Republic of China

*Corresponding author email: chencg1629@hfut.edu.cn (Cong-gui Chen); mafeishiyong@126.com (Fei Ma)

I. INTRODUCTION

Dietary fats are associated with a high incidence of obesity and related disorders. Extensive research has been focused on the substitutes for fat of meat [1]. Resistant corn starch (RCS), a specific dietary fiber with potential physiological benefits, has been proved to be favorable to the development of low-fat restructured meat products in respect of improved gel properties [2]. However, the improved mechanism has not been sufficiently understood, especially in myosin system. We examined the effects of 0-0.6% RCS on the water holding capacity (WHC) and strength of heat-induced poultry myosin gels.

II. MATERIALS AND METHODS

The extraction of myosin was executed according to our previous work [3]. The myosin-RCS solutions were prepared with addition of 0, 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6%, w/w RCS, then all of the mixtures were heated in a water bath set to 80 °C for 30 min to form a gel. WHC was expressed as the percentage of the gel weight retained after centrifugation. The gel strength was determined by a TA-XT Plus Texture Analyzer and was expressed as the maximum sustained compression force. Fourier transform infrared spectroscopy (FT-IR), low field nuclear magnetic resonance (LF-NMR) and scanning electron microscopy (SEM) measurements were also carried out, respectively. Comparison of multiple samples was conducted by ANOVA using SPSS 22 software (IBM). Values of $P < 0.05$ were considered to be statistically significant.

III. RESULTS AND DISCUSSION

A. WHC and gel strength

The WHC of myosin-RCS gels increased successively ($P<0.05$) with elevated concentrations of RCS in the range of 0.1-0.6% (w/w), except at the 0.3% RCS level (Fig. 1A). The enhanced WHC could be largely relevant to the swelling and gelation of RCS granules embedded in the myosin gel matrix [4] and the ease of leaching out of amylose.

The strength of myosin-RCS gels was improved significantly ($P<0.05$) with increased levels of RCS (Fig. 1B). The 0.6% RCS contributes to the greatest gel strength. The positive correlation between RCS addition and gel strength could be ascribed to retrogradation of amylose and the swelling-induced active filling.

B. FT-IR

The added RCS could significantly ($P< 0.05$) decrease the β-sheet content and increase the α-helix content, resulting in myosin-RCS with more thermal stability, lower effective partial unfolding of the myosin helical tail and higher WHC. No significant difference ($P> 0.05$) was noticed in β-turn percentages (Table 1).

Table 1 Percentage changes in the three main secondary structures as calculated by Gaussian curve-fitting procedure

$^{a-c}$ Different letters in the same row indicate statistically significant differences at $P<0.05$

Sample	0.0%RCS	0.1%RCS	0.2%RCS	0.3%RCS	0.4%RCS	0.5%RCS	0.6%RCS
β- Sheet (%)	46.80±0.99^{c}	42.10±0.28^{bc}	43.3±2.26^{bc}	42.4±1.27^{bc}	42.05±1.34^{bc}	41.60±3.54^{b}	34.75±2.05^{a}
α- Helix (%)	38.50±0.57^{a}	42.00±0.28^{ab}	41.50±1.41^{ab}	42.15±0.92^{ab}	43.30±0.85^{b}	43.30±2.97^{b}	50.30±2.83^{c}
β- Turn (%)	14.70±0.42^{a}	15.90±0.00^{a}	15.20±0.85^{a}	15.15±0.07^{a}	14.65±0.49^{a}	15.10±0.57^{a}	14.95±0.78^{a}

C. LF-NMR

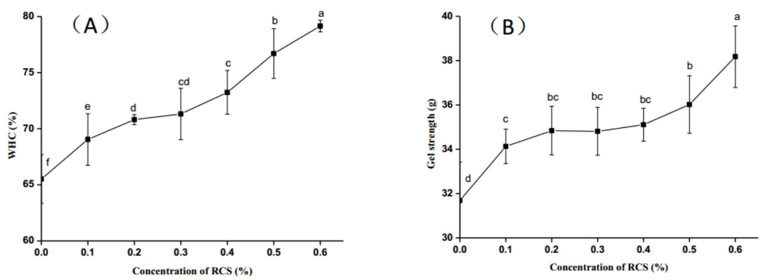
As shown in Table 2, the positions of T_{22} and T_{23} clearly shifted toward shorter transverse relaxation times over 0.2% RCS (P<0.05) and T_{22} exhibited continuous attenuation with increased levels of RCS. The decline of T_{22} and T_{23} values implied that RCS could weaken the water mobility and thus increase the WHC.

Table 2 Effects of 0–0.6% RCS on the spin−spin relaxation times (T_{22} and T_{23}) of myosin gels
$^{a\text{-}d}$ Different letters in the same row indicate statistically significant differences at P<0.05

Sample	0.0%RCS	0.1%RCS	0.2%RCS	0.3%RCS	0.4%RCS	0.5%RCS	0.6%RCS
T_{22}	386.17 ± 30.36^{d}	305.39 ± 0^{ab}	351.12 ± 0^{c}	285.50 ± 22.97^{a}	278.87 ± 22.97^{a}	295.45 ± 19.89^{ab}	328.26 ± 26.40^{bc}
T_{23}	2848.04 ± 0^{b}	2477.08 ± 0^{a}	2477.08 ± 0^{a}	2477.08 ± 0^{a}	2477.08 ± 0^{a}	2477.08 ± 0^{a}	2477.08 ± 0^{a}

D. SEM

The 0.2-0.4% RCS formed a network with some larger cavities and coarse cross-linked clusters (Fig. 2B, 2C), and the more RCS, the larger the clusters. The 0.6% RCS turned the gel network into a continuous, homogeneous structure (Fig. 2D). The structure favored the improvement of WHC and gel strength.



s of RCS on the WHC(A) and strength (B) of myosin gels.
e curve indicate that the different letters are ignificantly different (P<0.05).

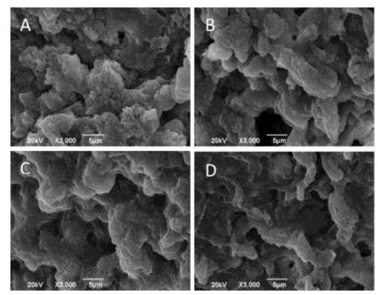


Figure 2. SEM images of myosin gel(A),myosin+0.2% RCS gel (B), myosin+0.4%RCS gel (C) and myosin+0.6%RCS gel (D)

IV. CONCLUSION

An increasing amount of RCS (0.1-0.6% w/w) successively improved the WHC and the strength of myosin-RCS gels. The shrinking mobility of inner water in the gels was responsible for the increased WHC. The swelling-induced active filling of RCS promoted the formation of a continuous and homogeneous three-dimensional network, thus resulting in reinforced gel strength. The heat-induced conformational transition from the β-sheet to the α-helix also improved the WHC and gel strength. It is promising to use RCS as a fat substitute in the development of novel low-fat meat products with potential physiological benefits in industry.

ACKNOWLEDGEMENTS

We thank associate professor Bin Zhang from Bengbu College, Jing Yao for their help during this experiment. This work was financially supported by Anhui Science and Technology Major Project in 2017 (17030701026).

REFERENCES

1. Yao, J., Zhou, Y., Chen, X., Ma, F., Li, P., & Chen, C. (2018). Effect of sodium alginate with three molecular weight forms on the water holding capacity of chicken breast myosin gel. Food Chemistry, 239, 1134-1142.
2. Nugent, A. P. (2005). Health properties of resistant starch. Nutrition Bulletin, 30(1), 27-54.
3. Chen, X., Chen, C. G., Zhou, Y. Z., Li, P. J., Ma, F., Nishiumi, T., & Suzuki, A. (2014). Effects of high pressure processing on the thermal gelling properties of chicken breast myosin containing κ-carrageenan. Food Hydrocolloids, 40, 262-272.
4. Khalil, A. H. (2000). Quality characteristics of low-fat beef patties formulated with modified corn starch and water. Food Chemistry, 68(1), 61-68.