FSMILE 2025

October 04-07, 2025
@Morioka & ZOOM Cloud

International Symposium on Food Communications and Sustainable Agri-Aqua Food Systems
Connecting Primary Industries, Academia, and Society through the SDGs

Synergistic enhancement of gelation and protein interactions in low-salt shrimp gels by static magnetic field and microcrystalline cellulose

Chunyu Li[a,b], Siyang Liu[a,b], Yang Yingying[a], ChunhongYuan[c], Tong Zhang[d], Tao Huang[a,b], Wenge Yang[a,b], HuamaoWei[a,b*]

1.College of Food Science and Engineering, Ningbo University, Ningbo 315211, China

2. Zhejiang Key Laboratory of Intelligent Food Logistic and Processing, Zhejiang-Malaysia Joint Research Laboratory for Agricultural Product Processing and Nutrition, Ningbo University, Ningbo 315211, China

3. Faculty of Agriculture, Iwate University, Ueda 3-18-8, Morioka, Iwate 020-8550, Japan

4. Zhejiang Fengling Holding Group Limited Company, Hangzhou 311113, China

Contact Information:
15888079118@163,com

INTRODUCTION

The red shrimp (*Solenocera crassicornis*) is distributed in Zhoushan, the South China Sea, and the southern Yellow Sea. It is a major ingredient for shrimp gel products due to its delicious taste and good processability. Traditionally, shrimp paste requires the addition of 2% to 3% salt to facilitate gelation. However, high salt intake is associated with various chronic diseases. The World Health Organization recommends a daily sodium intake limit of 5 g. Developing low-salt shrimp gel without compromising quality has become a hot topic in food research.

AIM

To achieve the low-salt goal, we introduced two key methods: microcrystalline cellulose (MCC) — a natural dietary fiber that can thicken, retain moisture, improve sensory properties, and reduce the risk of chronic diseases; and low-temperature static magnetic field (SMF) — a green, additive-free physical method that can regulate protein conformation. We hope that this combination will enhance the gel strength, improve the water retention, and optimize the microstructure of shrimp gel under low-salt conditions. This will provide theoretical basis and technical support for the development of new types of shrimp gel products that are healthy, high in dietary fiber, and have high textural properties.

METHOD

During the experimental process, we used fresh-frozen red shrimp as the raw material. After thawing and chopping, the shrimp were evenly divided into six groups. Each group was supplemented with 0%, 0.2%, 0.4%, 0.6%, 0.8%, and 1.0% (w/w) MCC, respectively, along with 1% (w/w) salt and 5% (w/w) potato starch. Subsequently, the moisture content of the mixtures was adjusted to 78%–80%, and they were filled into casings with a diameter of 38 mm. Next, each group of samples was exposed to a 5 mT SMF at 4 °C for 16 h to form shrimp paste sol (SS). Thereafter, the samples were heated in a water bath at 90 °C for 30 min to induce the formation of shrimp paste gel (SG). Finally, the physical properties, water distribution, and microstructure of each sample were comprehensively evaluated.

RESULTS

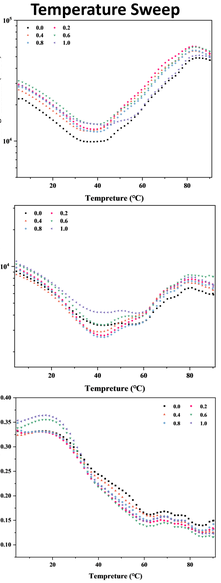
Physical Property

TPA, gel Strength and whiteness

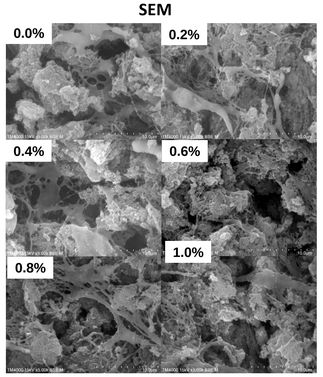
MCC added mass score	0	0.20	0.40	0.60	0.80	1.00
Hardness (g·mm)	1486.09±8.58^{f}	1758.71±44.11^{b}	1853.81±70.13^{ab}	1983.63±146.46^{a}	1892.72±83.86^{ab}	1863.61±110.40^{ab}
Springiness	0.88±0.29	0.90±0.02	0.91±0.18	0.91±0.07	0.89±0.03	0.90±0.31
Cohesiveness	0.74±0.01^{ab}	0.73±0.00^{ab}	0.72±0.01^{b}	0.73±0.02^{ab}	0.74±0.01^{a}	0.75±0.00^{a}
Gumminess (g·mm)	1101.11±23.85^{d}	1285.26±25.04^{c}	1343.52±41.88^{bc}	1452.29±77.96^{a}	1399.60±47.15^{ab}	1404.69±82.05^{ab}
Chewiness (g·mm)	970.90±18.78^{f}	1162.01±24.25^{b}	1217.85±38.15^{b}	1327.74±60.85^{a}	1243.06±75.02^{ab}	1230.76±33.83^{b}
Resilience	0.43±0.01^{ab}	0.43±0.00^{ab}	0.42±0.01^{b}	0.42±0.01^{ab}	0.41±0.00^{b}	0.44±0.00^{a}
Gel strength (g·mm)	3915.51±91.48^{g}	4772.91±25.86^{c}	5410.00±264.62^{b}	6478.07±407.11^{a}	5740.17±64.85^{b}	5806.32±85.85^{b}
Whiteness (°)	70.60±0.50	70.67±0.10	70.56±0.16	70.73±0.34	71.33±0.86	70.75±0.79

Different letters within the same group indicate significant differences. ($p<0.05$)

Rheological Properties Temperature Sweep

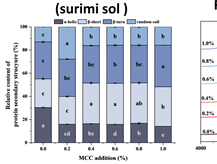


SEM

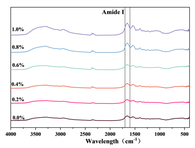


Chemical Property

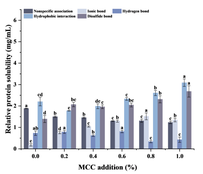
relative content of secondary structure (surimi sol)



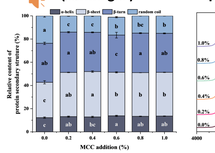
FT-IR spectra(surimi sol)



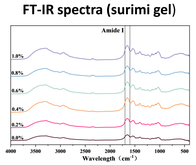
chemical bond (surimi sol)



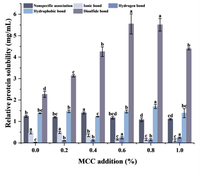
relative content of secondary structure (surimi gel)



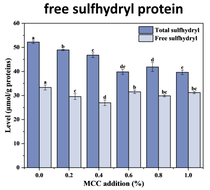
FT-IR spectra (surimi gel)



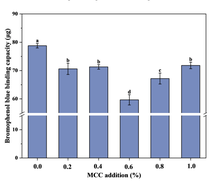
chemical bond (surimi gel)



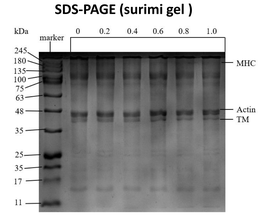
total sulfhydryl and free sulfhydryl protein



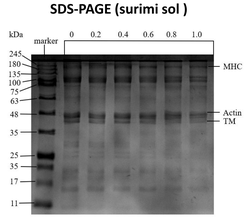
hydrophobicity



SDS-PAGE (surimi gel)

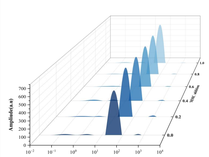


SDS-PAGE (surimi sol)

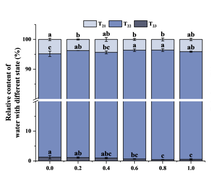


Water Retention Analysis

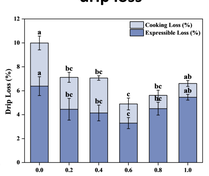
relaxation time



water distribution



drip loss



CONCLUSIONS

This study investigated the synergistic effects of static magnetic field (SMF) and microcrystalline cellulose (MCC) on the properties of low-salt shrimp gel (SG). Experiments from multiple perspectives confirmed that MCC induces β -folding and bridges myosin heavy chains, constructing a dense and uniform protein network. In summary, with the assistance of SMF, MCC significantly improved the functional properties of low-salt shrimp gel, providing a new method for developing high-quality, low-sodium, and dietary fiber-rich seafood products.

ACKNOWLEDGEMENTS

Chunyu Li: Writing – original draft, Methodology, Data curation. Siyang Liu: Methodology, Data curation, Investigation. Yingying Yang: Investigation, Methodology. Chunhong Yuan: Writing – review & editing. Tong Zhang: Writing – review & editing. Changrong Ou: Writing – review & editing. Wenge Yang: Writing – review & editing. Huamao Wei: Methodology, Writing – review & editing, Supervision, Funding acquisition, Writing – original draft, Software, Investigation, Data curation.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

This work was financially supported by the National Natural Science Foundation of China (32102024), China.

No data was used for the research described in the article.