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Utilization of Celluloses from Pomelo (Citrus grandis) Albedo as Functional Ingredient in Meat Marination

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Abstract. The potential of cellulose and nanocellulose from pomelo (Citrus grandis) albedo as water-binding agent in meat marination system were evaluated. Moisture content and water holding capacity (WHC) of the cellulose-marinated chicken breasts were determined with and without the presence of salt. Results showed that samples marinated with 3% salt have better performance compared to samples without salt. The use of cellulose in marinades system without salt is more effective in improving the WHC (65.14%), significantly higher than those of nanocellulose (63.28%). The results also showed that salt consumption has increased the value of WHC by nearly 10-15%, with the highest scores ($p < 0.05$) are commercial cellulose samples followed by extracted cellulose samples, 81.34% and 78.70% respectively. The physical analysis of marinated meat also indicates these materials as new promising functional ingredients that need to be further explored.

Keywords: Pomelo albedo, cellulose, nanocellulose, marination, chicken breast meat.

1. Introduction

Poultry meat is one of the highly demand meat worldwide, because of its natural flavor and consistency, that allows for producers to imparts desired flavour profiles. However, juiciness and tenderness of the meat is highly affected by amount of water or moisture content, which may affect the quality of final products [1]. The ability of the muscle to retain its own water content or added water is called water holding capacity (WHC) and this can be accomplished by marination techniques and the addition of functional ingredients. Marination, is one of culinary techniques that incorporates a liquid marinade (contain any ingredients) to improve flavour, texture and juiciness of muscle foods [2], [3].

The addition of functional ingredients helps to modify the overall technological and sensorial characteristics of a meat system including WHC. These ingredients can be categorized based on their mechanisms of action; i) salt which are added in order to enhance functionality of muscle protein (myofibrillar), and ii) organic compounds (animal or plant origin) which play indirect effect on water and texture by working on myofibrillar proteins, for example hydrocolloid, gelatins, soy and milk protein [4], [5]. Furthermore, the use of fibres to develop the quality of meat products is a promising trend. Fibres have multifunctional properties and have been added to increase the cooking yield, reducing formulation cost and enhancing texture of meat products [6].

There are numbers of citrus fibres available in the market and these materials are usually by-products of juice and pectin manufacturing. Besides pectin, cellulose is one of the functional fibres which can be further used as functional food ingredient. Due to the availability of supply and cost consideration, cellulose can also be used as a starting material to produce cellulose derivatives and also nano-scale cellulose, which called

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nanocellulose. Pomelo (Citrus grandis) albedo is an example of the utilization of citrus waste (peel) that can be converted into functional ingredients such as cellulose and nanocellulose [7]. Moreover, the cellulose content in pomelo albedo was 21%, significantly greater than orange peel, at 14% and therefore, it is a great source of cellulose compared to the other types of citrus [8].

The incorporation of water-binders into marinades has become a relatively new topic of interest, due to their exceptional inherent water-binding and texture modifying abilities, by suspending other particulates in marinades [9]. Previous studies have been carried out on the WHC effect of water-binders (i.e. pectin and hydrolysed soy protein) of injected-chicken breast meat [10]-[12]. Generally, water-binder produced a viscoelastic gel matrix that capable of immobilising extraneous water, therefore increasing its WHC by strong hydrophilicity of binder [13]. However, little information is available on the use of cellulose and nanocellulose as a water-binder in marinade formulation and their specific capability in increasing WHC of meat.

This work is carried out to determine the potential of cellulose and nanocellulose isolated from pomelo albedo as water binding agent in tumbled-marinated meat system. In this study, the presence of salt and how it affects the marination performance of marinated chicken breast was also evaluated.

2. Materials and Method

2.1. Marinate Formulation

Fresh, skinless chicken breast fillets were obtained from Jati Mesra Sdn. Bhd. (Batu Caves, Selangor). Fillets were received in a range of weight from 150-250 g, and any remaining surface fat was physically removed. Test marinades, (meat/marinade ratio was 80:20) were prepared one day earlier prior to marinating process and held at 4 ℃ until used. All marinating solutions were comprised of water, salt and cellulose materials (as binding agent) (Table 1).

Table 1: Marinade formulation

Sample	Binding agent (g/100g)	Salt (g/100g)	Water (g/100g)
Cellulose	0.5	0	99.5
Nanocellulose	0.5	0	99.5
Commercial cellulose	0.5	0	99.5
Control	0	0	100
Cellulose	0.5	3.0	96.5
Nanocellulose	0.5	3.0	96.5
Commercial cellulose	0.5	3.0	96.5
Control	0	3.0	97.0

Pomelo was obtained from a fruit stall (Tambun, Perak). The albedo part was peeled and oven dried (Protech, Malaysia) before grinded into powder form using a grinder (Panasonic, Malaysia). Commercial cellulose (20 µm of size, Sigma Aldrich) was used as a reference.

2.2. Preparation of Cellulose and Nanocellulose from Pomelo Albedo

The methods were described from Zain et al. [7]. Cellulose was prepared via alkali treatment followed by bleaching process, while nanocellulose was produced via hydrolysis using sulphuric acid. The extracted cellulose produced in a size of less than 500 µm, while nanocellulose produced in a range of diameter from 2-6nm and length 100-150nm (Fig. 1).

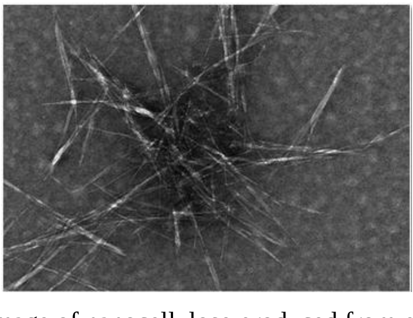


Fig. 1. TEM image of nanocellulose produced from pomelo albedo.

2.3. Marinating and Cooking

Marinating process was done by using commercial tumbler (The Biro, USA) in polyester bags for each sample (with or without 3% salt) for 20 min at 10 rpm. Samples were subsequently cooked at 170 ℃ in force air convection oven (Protech, Malaysia) for approximately 20 min to an internal temperature of 74 ℃.

2.4. Water Holding Capacity (WHC)

Water-holding capacity was determined following the method by Bianchi et al. with some modification [14]. Cooked samples were cut into a piece of meat (approximately 200 mg) and a piece of filter paper (Sartorius Stedium Grade 292) was positioned on the top and another piece on the bottom to absorb the expressed moisture. Compression test was performed with a maximum load of 1kg was applied to the sample and this force was held constant for a total test time of 5 min. The sample weight was recorded. WHC of samples was calculated from:

WHC (%) = 100% - [(weight of wet filter paper – weight of dry filter paper) / weight of sample] X 100%

2.5. Moisture Content

A 4g of each sample was cut and put into aluminium plates. Prepared samples were put into the oven (100˚C) for 24 hrs [15]. Samples were weighed and recorded after drying until constant weight achieved.

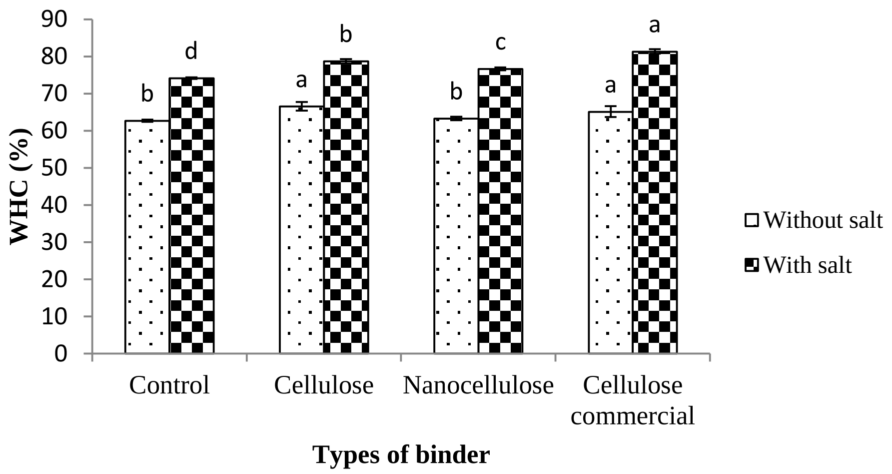
Moisture content was calculated from:

Moisture content (%) = (weight of sample before drying – weight of sample after drying) / weight of sample before drying X 100%

3. Results and Discussion

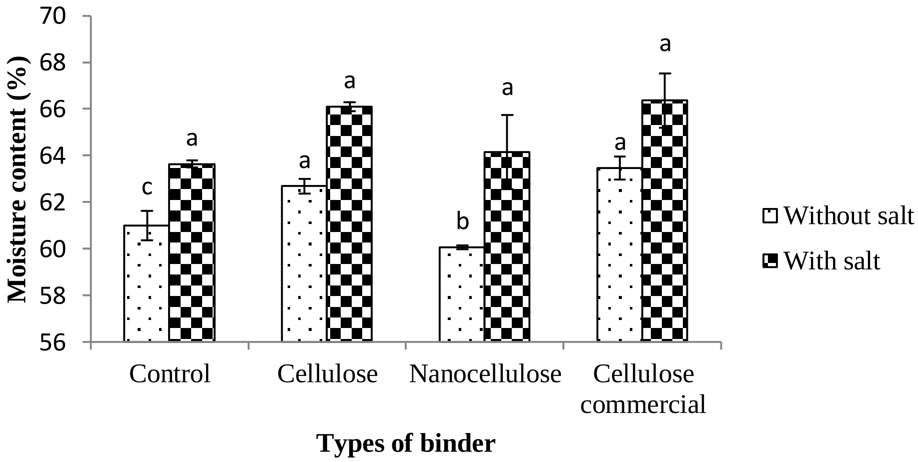
3.1. Water Holding Capacity (WHC) and Moisture Content

In this study, the WHC of the marinating system in both systems (with/without salt) was also assessed to determine the efficiency of each citrus-based cellulose and nanocellulose as well commercial cellulose as a water-binder (Fig. 2). It is also proved that salt plays a crucial role in a marinated meat's quality as it has a direct effect on meat by protein solubilization and texture modification. The marinating system containing salt shows greater WHC value for about 10-15% higher than the marinating system without salt. Thus, the WHC on the without salt samples was not dramatically enhanced (62-66%). The difference was due to the absence of the coating system from gel matrices that enable water evaporation and melted fat to escape from the muscle fibers which justifies the results obtained for cooking loss [14]. However, commercial cellulose samples possessed the highest WHC values ($p < 0.05$), followed by cellulose, nanocellulose and control samples, with the value of 81.34%, 78.70%, 76.68% and 74.16% respectively. Higher WHC value indicates to the good marinating performance and better quality of meat products.



[a] Same letters above the bars indicate significant difference among the samples (p>0.05)

Fig. 2. WHC (%) for marinated chicken breast meat at different types of binder (n=3).



[a] Same letters above the bars indicate significant difference among the samples ($p>0.05$)

Fig. 3. Moisture content of marinated chicken breast meat at different types of binder (n=3)

Moisture contents of all samples are shown in Fig. 3. Cooking process significantly decreased moisture content, which could be related to the cooking loss of samples. The significantly lower ($p < 0.05$) moisture content was observed in without salt samples (60-63%), with the highest values corresponded to the commercial cellulose sample (63.45%), followed by cellulose sample (62.67%), control and nanocellulose samples (60.99% and 60.05% respectively). This could suggest that the cellulose sample contains more moisture compared to nanocellulose sample, even though nanocellulose absorbed more marinade during marination process.

Moreover, the similar moisture distribution in samples containing salt, even though the values are slightly higher than samples without salt (63-66%). Moisture content is in agreement with cooking yield values of each sample and the presence of salt had improved the moisture content of marinated breast meats. From the results, the value of moisture content in nanocellulose sample is significantly lower (64.15%) compared to the cellulose sample, 66.09%. However, commercial cellulose sample resulted in highest moisture contents, 66.36%. Therefore, it may be reasonably be suggested that there are significant differences ($p <0.05$) that the additional of cellulose materials had improved the moisture content of marinated chicken breast meats compared to control samples.

4. Conclusions

The effect of different types of cellulose materials (cellulose, nanocellulose and cellulose commercial) at the different marinating conditions (with and without salt) have led to changes in physical properties, moisture content and WHC of marinated chicken breast meats. Marinade containing salt had the greater marinating performance, compared to the other treatment (without salt) and the samples looked tender, with a uniform gel matrix formation that prevent direct heating during cooking. Even though commercial cellulose sample had better moisture content and WHC, sample from extracted cellulose also had almost similar effect and can be considered as a viable alternative as a water-binder in industrial application, compared to nanocellulose.

5. Acknowledgments

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