Effect of kappa-carrageenan on physicochemical properties of mantou (Chinese steamed bread)

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Abstract. Carrageenan is used in the food and non-food industries as a thickener and demonstrated form gels and emulsion stabilizers. The physicochemical properties of carrageenan affect the strength of the gel that could improve texture properties. Mantou is chinese steam bread that has less tender, which generally were prefered had a soft texture. Mantou content low crude fibre and rich of carbohydrate. The aims of this study is to determine the effect of adding kappa-carrageenan to the physicochemical properties of mantou product. The research method was used completely randomized design (CRD) with five treatments and four replications. The treatment was the addition of kappa-carrageenan concentration by 0% (as control), 1.5%, 2%, 2.5%, 3%. The main physicochemical properties observed were the mantou texture and fibre content. The results of this study are the addition of kappa-carrageenan showed an effect on texture and increases nutrient fibre of mantou.

1. Introduction
Kappa-carrageenan is polysaccharides that were extracted from Kappaphycus alvarezi, which can form a high gel. Carrageenan is often used in the food and non-food sectors. Carrageenan in food products has a function as a thickener and can form gels and stabilizers while in non-food products it is used in pharmaceuticals and cosmetics industries [1]. Kappa-carrageenan fortification in ice cream and fish galantine reported enhance physicochemical properties and showed good acceptability in organoleptic test [2,3].

Kappa-carrageenan has many benefits, especially in the food industry, including being able to function as a gelling agent, stabilizer, emulsifier, suspension, and dispersant [4]. One of the food products that could be added using carrageenan is mantou. Mantou as Chinese steamed bread is one of the traditional fermented yeast foods and steamed wheat products from China, which contain carbohydrate as the main ingredient. This research was determined the addition of kappa-carrageenan into mantou to improve the physicochemical properties of mantou products and specially to obtain increasing fibre content that gives more benefit to the human diet. Moreover, fortification kappa-carrageenan in mantou product is a novelty that remains unstudied.

2. Materials and methods
2.1 Materials
This study was used wheat flour 40.9%, glucose powder 6.7%, yeast 0.3%, salt 0.5%, white margarine 3.4%, milk powder 2%, tang mien 23.9%, baker bonus 0.2%, and water 22%. This study was conducted...
using experimental methods, the research design was used consisted of five treatments with four replications. This study used a completely randomized design (CRD) consisting of 4 treatments (1.5; 2; 2.5; and 3 % of kappa-carrageenan). The process begins by weighing all the necessary ingredients. The process continued by mix all the ingredients using a mixer. The next step is to steam the dough using the desired size and shape, then steam it at 50 °C [5] for 20 minutes.

2.2 Physicochemical properties
The Mantou was evaluated based on physicochemical properties such as texture (hardness, cohesiveness, and springiness) using texture analyzer and chemical properties (moisture, fat, protein, carbohydrate, fibre, and ash) content of mantou products followed [6].

2.3 Data Analysis
The data were analysed using Analysis of Variance (ANOVA) then continued with the Duncan’s Multiple Range Test (α=0.05). All data were analysed using IBM SPSS version 20, USA.

3 Results and discussion
3.1 Mantou physical properties
Analysis of variance showed that the addition of kappa-carrageenan in each treatment showed an increase in the hardness of mantou products with the addition of kappa-carrageenan. Analysis of variance showed that the highest addition of kappa-carrageenan by 3 % to be the treatment with the highest value. The highest hardness was obtained in the 3% treatment and the lowest hardness was obtained by the control treatment. This addition shows that the addition of kappa-carrageenan has a significant effect on the hardness value of the mantou kappa-carrageenan product.

Cohesiveness is the ratio of the pressure area during the second compression to the first compression [7]. The addition of kappa-carrageenan to mantou products has a significant effect on the cohesiveness of the product. The 3 % treatment with the addition of the highest kappa-carrageenan concentration had the highest cohesiveness value, while the lowest cohesiveness value was shown in the control treatment.

The elasticity of the mantou texture test with the addition of kappa-carrageenan is represented by the springiness value. The value of the springiness of the mantou kappa-carrageenan product shows an increase in each treatment, the longer it is used, the higher the springiness value. Analysis of variance showed no significant difference in the addition of kappa-carrageenan to springiness, 2.5 and 3% treatments were the highest results and had the same value, but 3% treatment was the treatment with the highest springiness value. The control treatment (0% kappa-carrageenan) showed the lowest value of springiness.

Mantou texture in this study obtained results from the parameters of hardness, springiness and cohesiveness which increase in proportion to the treatment. The hardness of adding carrageenan kappa makes the product tougher. Hardness values are not only measured at their maximum stresses, they prevent the product from being pushed to the maximum point. This addition proves that the addition of carrageenan can affect the hardness of the product due to its water-binding ability [8].

Kappa-carrageenan which has hydrophilic properties can bind water as well as stabilize the emulsion from the product [9]. This property causes the higher the provision of kappa-carrageenan to make mantou kappa-carrageenan to have a hardness which tends to be hard.

Springiness or elasticity will increase with increasing water content [7]. The ability of carrageenan to bind water well also increases the value of springiness. Springiness is influenced by temperature and will increase at low temperatures around 30 °C in 6 hours. The cooking temperature of kappa-carrageenan mantou at 60 °C also affects the value of springiness, this is supported by the statement of [10] that drying above 50 °C the texture of the product will result in a lot of wrinkles and less elasticity.

Cohesiveness is the ratio of the pressure area to the first compression and has no unit, cohesiveness can also be measured as the rate at which the material is mechanically crushed [7]. The increase in cohesiveness value causes the product to be more compact. The increase in the cohesiveness value
due to the decrease in the amount of free water so that the distance between the particles becomes narrower. Physical properties data of mantou were summarized in table 1.

**Table 1. Physical properties of mantou made from kappa-carrageenan**

| Kappa-carrageenan content | Hardness (Kg/f) | Cohesiveness | Springiness |
|---------------------------|----------------|--------------|-------------|
| 0% (control)              | 4.52±0.59a     | 0.63±0.01a   | 0.94±0.02a  |
| 1.5%                      | 4.97±0.79a     | 0.63±0.03a   | 0.95±0.01a  |
| 2%                        | 5.08±0.15a     | 0.75±0.04b   | 0.96±0.05a  |
| 2.5%                      | 6.04±0.37b     | 0.76±0.06b   | 0.97±0.03a  |
| 3%                        | 6.10±0.56b     | 0.82±0.02c   | 0.99±0.02a  |

1 Different letter within a Column was showed different significant between treatment (p<0.05).

### 3.2 Chemical properties of Mantou

The results of the analysis of variance showed that the addition of kappa-carrageenan for each treatment had a significant effect on the chemical properties, especially the fibre value. The addition of 3% in treatment was presented the highest fibre addition effect among all treatments.

The proximate test results of the mantou added with kappa-carrageenan product ranged from 1.33% to 4.21%. The results of the analysis showed that the addition of different kappa-carrageenan showed a significant effect on the crude fibre value of the mantou kappa-carrageenan product, the addition of kappa-carrageenan in the 3% treatment had the highest crude fibre content, while the treatment without the addition of kappa-carrageenan made the treatment with the lowest crude fibre content.

The increase in the addition of concentration in each treatment showed that the control treatment demonstrated the least fibre content because it only gets fibre from wheat flour which is the basic ingredient of making mantou. The value of crude fibre in mantou kappa-carrageenan increased along with the addition of kappa-carrageenan up to 4.21%. and those found in carrageenan is a type of water-soluble fibre [10].

The addition of kappa-carrageenan to mantou products not only affects the fiber of mantou carrageenan products. The chemical properties in mantou kappa-carrageenan also directly get the effect of this addition. Carbohydrate content decreased which was directly proportional to the addition of kappa-carrageenan concentration to each treatment. Inversely proportional to the analysis of carbohydrates, fat, protein, water, and ash has increased with each addition of kappa-carrageenan concentration.

The chemical analysis of carbohydrates did not increase because carrageenan flour only contained carbohydrates in the range of 20% [11] to 29.07% [12] so that the provision of carrageenan flour did not affect the carbohydrate content of carrageenan mantou products. Chemical analysis of fat also does not affect and decreases in each treatment, presumably because carrageenan flour has fat content 8.6% [12]. This happens because carrageenan flour is made from seaweed which has a fat content of 0.13% to 8.6%. The decrease in each of these treatments can also be caused by the breakdown of fat by water into glycerol and fatty acids. The presence of water, fat can be hydrolysed into glycerol and fatty acids [13].

In the chemical analysis test, the percentage increases gradually according to the addition of kappa-carrageenan concentration. This occurs presumably because carrageenan flour can bind to the protein. Carrageenan can bind to proteins to become proteocarragelates, thereby increasing the surface area that can absorb or bind water [14]. The chemical test of the ash content has increased because it is suspected that carrageenan flour has organic content so that during the heating process it causes the mineral material to increase and leaves the mineral. To form a gel, carrageenan also functions to form a three-dimensional network with sugar and water in synergistic conditions, with the formation of a three-dimensional network, water will be trapped and not easily come out [15].
Table 2. Chemical properties of mantao made from kappa-carrageenan

| Treatment   | Carbohydrates (%) | Protein (%) | Lipid (%) | Water (%) | Ash (%) | Crude Fiber (%) |
|-------------|-------------------|-------------|-----------|-----------|---------|-----------------|
| 0% (control)| 46.96±0.31a       | 12.47±0.08b | 3.41±0.11d| 33.54±0.81c| 2.29±0.13c| 1.33±0.15a      |
| 1.5%        | 44.71±0.14a       | 12.34±0.15a | 2.86±0.03c| 34.41±0.17b| 2.24±0.07b| 3.16±0.03b      |
| 2%          | 43.69±0.99b       | 13.06±0.05c | 2.49±0.05b| 34.28±0.07b| 2.79±0.06c| 3.48±0.04bc     |
| 2.5%        | 42.66±0.08b       | 13.33±0.03d | 2.23±0.02d| 34.00±0.05c| 3.23±0.03d| 3.75±0.04ad     |
| 3%          | 41.53±0.59a       | 13.69±0.02c | 2.16±0.02d| 45.04±0.12d| 3.37±0.02e| 3.96±0.49d      |

Different letter within a Column was showed different significant between treatment (p<0.05).

4 Conclusion
The addition of kappa-carrageenan to mantou with various concentrations had a significant effect on improving the texture and adding the nutritional value of mantou.

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