# EFFECTS OF A DIETARY CHITOSAN-ALGINATE-FE(II) COMPLEX ON MEAT QUALITY PIG LONGISSIMUS MUSCLE DURING AGEING

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## Introduction

Chitosan is a cationic polysaccharide made from alkaline N-deacetylation of chitin. The component has multifunctional properties, including antibacterial (Jia et al., 2002; Xie et al., 2001; Sudarshane et al., 1992) fungicidal (Allan and Hadwiger, 1979), and antioxidant functions (Xie et al., 2001; Jeon et al., 2003). On the other hand, early studies showed that alginate, the polymer of β-D-mannuronate and its C-epimer form of α—L-guluronate inhibited the production of NO and H2O2 (Mo et al., 2003), and consequently exhibited antioxidant and antitumor effects by improving metabolic activity (Michio and Terukazu, 1992).

Given the previous studies, it was reasonable to assume that if chitosan and/or alginate are deposited in muscle tissue, lipid oxidation and microorganism growth could be significantly retarded. Chun et al. (2003) demonstrated a possible use of chitosan-alginate complex in the pig industry by showing that more than 90% of piglets with diarrhea benefited from oral feeding of the complex. By applying an isotope tracing technique, we previously showed that approximately 0.43% of isotope-conjugated chitosan-alginate-Fe(II) complex (CAFC) was deposited in pig muscle tissue (Korean Department of Agriculture and Forestry, 2002). However, its effect on meat quality has not yet been evaluated

## Objectives

The objective of this study was to investigate the effects of dietary CAFC supplementation on carcass and meat qualities of pig m. longissimus during chiller ageing.

## Methodology

Animals, experimental design and treatment: A total of 122 LYD (Landrace × Yorkshire × Duroc) pigs were sampled from an industrial population. Seventy-four pigs (32 gilts and 42 barrows) were administered to a 3 mL of dietary supplementation of CAFC, diluted in water, per day from 25 to 70 days of age, while the remaining 48 pigs (20 gilts and 28 barrows) were fed with the same commercial diet without the

supplementation. After the experimental period, an ordinary feeding regime was applied for all pigs until approximately 110 kg of slaughter weight was reached. All pigs were slaughtered after being stunned by an electronic stunner (230 volts for 2.5 s) at an industrial abattoir, and placed at a 1°C chiller until the following day. CAFC was manufactured by polymerizing two volumes of chitosan (MW 2,000-3,000, Tahoon Chemicals, Korea) and one volume of alginate (MW 1,500-2,000, EcoBio Inc, Korea) with 3% of $Fe_2SO_4$ at 90°C for 2 h (Korean Department of Agriculture and Forestry, 2002).

Sampling and measurement of objective meat quality: The day following slaughter, carcass grade was evaluated by carcass graders from the Korean Animal Products Grading Service (APGS, 2001). To evaluate the effect of CAFC supplementation on stability in objective meat quality during chiller ageing, 20 barrows (10 of each treatment) were randomly sampled, and longissimus muscles (from the 7th thoracic vertebrae to the last lumbar vertebrae) were taken from the left sides. The muscle samples were cut into 6 portions of ca. 150 g, vaccum packed, and randomly assigned to six ageing treatments (3, 7, 12, 16, 20, and 25 days post-mortem).

**Results & Discussion**

As seen in Table 1, the treatment had no significant effect on pH, meat color and WHC during ageing. pH at 24 h post-mortem has a direct effect on meat color and WHC through its effects on protein denaturation and the surface reflectance of muscle fiber (Bertram et al., 2004). The studies implied that the objective meat qualities of meat color and WHC were largely related to post-mortem glycolytic. Given the fact, the current result of the similar pHs and objective meat qualities between the treatments indicated that the dietary supplementation did not influence post-mortem glycolytic rate and likely amount of energy resources at the time of slaughter.

TBARS values as indicators of lipid oxidation have been used by numerous research groups (e.g., Jeon et al., 2003). The most significant result of the current study was that the dietary supplementation significantly retarded lipid oxidation, as assessed by TBARS. As seen in Fig. 1, meat from CAFC-fed pigs had significantly ($p<0.05$) lower TBARS values from 20 days of storage at 1°C, but at the practical storage temperature of 4°C, the beneficial effect would be detectable before that ageing time. The current study did not determine absorption and deposition rate of CAFC in longissimus muscle. However, we previously traced isotope-conjugated CAFC for pig, and found that a large portion of the feed additive was accumulated in the digestive organs, but also 0.43% of the fed-dose was detected in muscle tissue (KDAF, 2002). Given the apparent effect of both chitosan and alginate on antioxidant activity (Peng et al., 1998), it can be assumable that the current results suggest that the deposited CAFC maintained their functions to some extent during chiller ageing.

Another noticeable result was the significant effect of CAFC supplementation on VBN formation during ageing (Fig. 1). VBN is a measurement of the nitrogen component of protein degradation, but also includes metabolite products such as AMP (Takasaka, 1975). Significantly lower levels of VBN after 12 days of storage for the CAFC-fed pigs suggests a significant reduction in protein degradation for that group. Taken that negligible effect of the treatment on pH and temperature, significantly retarded formation

of VBN for the CAFC-supplied pigs was unlikely related to the previously proposed mechanisms, and suggested that other beneficial characteristic was involved. The current study did not determine the initial bacterial loads and their changes during ageing time. However, previous studies have demonstrated that chitosan and alginate had antibacterial functions (Jia et al., 2002), and that TBARS and VBN values were significantly increased when meat were contaminated by microorganisms (Chae et al., 2004). It is possible that antibacterial activity of the supplement alone could have caused reduction in the formation of TBARS and VBN.

## Conclusions

The current study showed that dietary supplementation of CAFC slowed down the formations of TBARS and VBN during chiller ageing.

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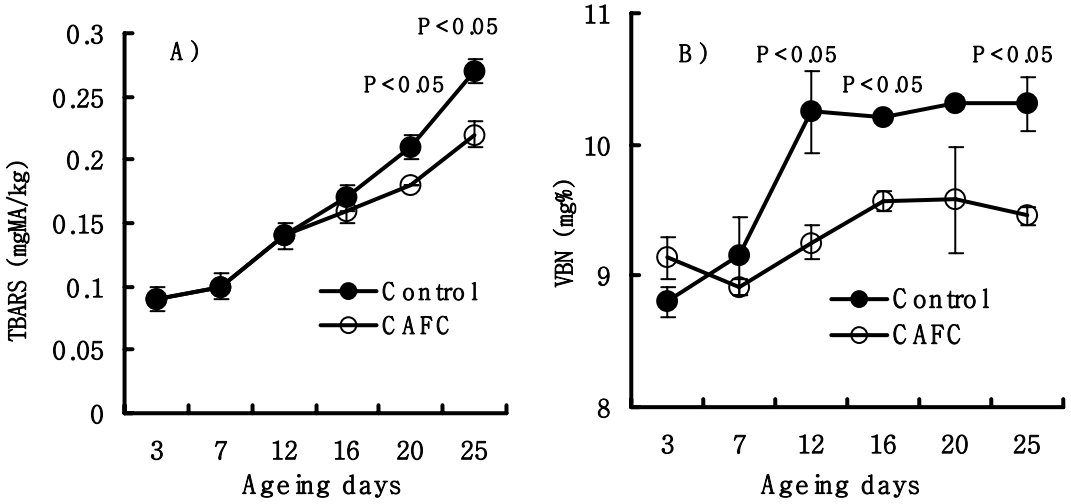


**Fig. 1. Effects of dietary supplementation of chitosan-alginate-Fe(II) complex (CAFC) on changes in (A) thiobarbituric acid reactive substances (TBARS) and (B) volatile basic nitrogen (VBN) in *m. longissimus dorsi* during chiller ageing. Bar: standard deviation.**

Table 1. The effects of dietary supplementation of chitosan-alginate-Fe(II) complex (CAFC) on changes in pH, objective meat color, water-holding capacity (WHC) and cooking loss (Cook loss) in *m. longissimus dorsi* during chiller ageing

| | | Day of ageing [Ψ] | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3 | 7 | 12 | 16 | 20 | 25 |
| pH | Control | 5.6±0.06 | 5.6±0.00 | 5.7±0.00 | 5.6±0.03 | 5.7±0.00 | 5.7±0.03 |
| | CAFC | 5.5±0.03 | 5.7±0.03 | 5.8±0.07 | 5.6±0.07 | 5.6±0.03 | 5.6±0.03 |
| CIE L* | Control | 54.4±0.32 | 56.5±2.21 | 57.4±2.10 | 56.8±1.7 | 56.8±0.64 | 57.5±0.82 |
| | CAFC | 54.6±0.85 | 53.1±2.43 | 55.6±1.81 | 57.4±1.6 | 57.7±1.06 | 55.2±0.63 |
| CIE a* | Control | 7.5±0.22 | 7.9±0.53 | 7.4±0.18 | 7.8±0.16 | 7.9±0.30 | 8.9±0.68 |
| | CAFC | 7.4±0.87 | 8.4±0.67 | 8.0±0.76 | 8.4±0.72 | 8.5±0.64 | 9.7±0.66 |
| WHC (%) | Control | 54.5±1.23 | 53.4±1.24 | 56.3±1.35 | 58.9±0.67 | 53.4±0.53 | 51.8±1.81 |
| | CAFC | 52.9±1.26 | 55.9±1.34 | 55.6±1.36 | 59.8±0.56 | 53.6±0.93 | 54.9±0.35 |
| Cook loss (%) | Control | 32.5±1.05 | 33.7±1.14 | 33.7±0.86 | 33.3±0.54 | 32.0±1.14 | 32.7±1.68 |
| | CAFC | 32.9±0.77 | 32.7±1.15 | 33.3±1.12 | 32.0±0.31 | 32.7±1.09 | 32.1±1.29 |

[Ψ] There was no significant effect of the feed supplementation on all meat quality traits within each ageing time ($p>0.05$).