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Comparison of antimicrobial activities of newly obtained low molecular weight scorpion chitosan and medium molecular weight commercial chitosan

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In this study the antimicrobial activity of low molecular weight (3.22 kDa) chitosan, obtained for the first time from a species belonging to the Scorpiones, was screened against nine pathogenic microorganisms (seven bacteria and two yeasts) and compared with that of medium molecular weight commercial chitosan (MMWCC). It was observed that the antimicrobial activity of the low molecular weight scorpion chitosan (LMWSC) was specific to bacterial species in general rather than gram-negative or gram-positive bacterial groups. It was also determined that LMWSC had a stronger inhibitory effect than the MMWCC, particularly on the bacterium *Listeria monocytogenes* and the yeast *Candida albicans*, which are important pathogens for public health. In addition, it was recorded that the MMWCC had a greater inhibitory effect on *Bacillus subtilis* than LMWSC. According to the results obtained by the disc diffusion method, the antibacterial activity of both LMWSC and MMWCC against *B. subtilis* and *Salmonella enteritidis* was higher than the widely used antibiotic Gentamicin (CN, 10 μg/disc).

[**Key words:** Antibacterial; Antifungal; Scorpion; Chitosan; Characterization; Molecular weight]

There is growing interest in using natural products in the treatment of microbial diseases because synthetic products contain various chemicals that can be toxic to the body (1,2). Chitosan is a natural product that occurs as a result of the alkaline deacetylation of chitin. It is non-toxic to both the environment and living organisms, biodegradable and biocompatible (3). Due to these properties, it is used as an antimicrobial agent both alone and as a composite (1,4). A literature search showed that there are three main factors (molecular weight, degree of deacetylation and bacterial strain) affecting the antimicrobial activity of chitosan (5–7).

The effect of molecular weight on the antimicrobial activity of chitosan has been emphasized in previous studies. However, there is still some confusion on this issue. For example, a general conclusion as to whether low, medium or high molecular weight chitosans show better antimicrobial activity could not be reached (8). While it was remarked in some studies that low molecular weight chitosan showed better antimicrobial activity against bacteria, yeasts and fungi (4,7,9), in other studies it was reported that high molecular weight chitosan was more effective against some bacteria than low molecular weight chitosan (6,10). Tikhonov et al. (4) reported that low molecular weight chitosan (4.6 kDa) and its derivative was more effective on bacteria, yeasts and fungi than other chitosans. Zheng and Zhu (8) remarked that while high molecular weight chitosan showed more effective antibacterial activity against the gram-positive bacteria *Staphylococcus aureus*, low molecular weight chitosan showed more effective antibacterial activity against the gram-negative bacteria *Escherichia coli*. Jeon et al. (6) stated that chitooligosaccharides with a higher molecular weight of more than 10 kDa showed more effective antimicrobial activity against pathogenic microorganisms than non-pathogenic. Therefore, more studies are needed to clearly identify the effect of molecular weight on the antimicrobial activity of chitosan and to eliminate this confusion.

It was revealed in previous studies that cationic amino groups, which increase depending on the increase in degree of deacetylation (DD) of chitosan, greatly increased the antimicrobial activity of the chitosan. These studies reported that chitosans with higher DD effectively suppressed the growth of mold and gram-positive and gram-negative bacteria (11–14).

The efficiency of the antimicrobial activity of chitosan differs depending on the bacterial strain. The antimicrobial activities of chitosan and its derivatives have been tested against a great variety of pathogenic bacteria so far (6,7,10,14,15). These studies have generally focused on *E. coli* and *S. aureus*, which are important pathogens in terms of public health and food hygiene. In the present study, antimicrobial activities of both chitosan obtained from scorpion, for the first time, and medium molecular weight commercial chitosan (MMWCC) were tested against three fish pathogens (*Lactococcus garvieae*, *Vibrio alginolyticus* and *Streptococcus agalactiae)*, four human pathogens (*Listeria monocytogenes*, *Yersinia enterocolitica, Bacillus subtilis* and *Salmonella enteritidis)* and two yeasts (*Candida albicans*, *Candida glabrata*).

Studies on chitin and chitosan have been focused on animals such as shrimp, crab, lobster and squid because they are easily accessible (16,17). Due to the same reason, the antimicrobial

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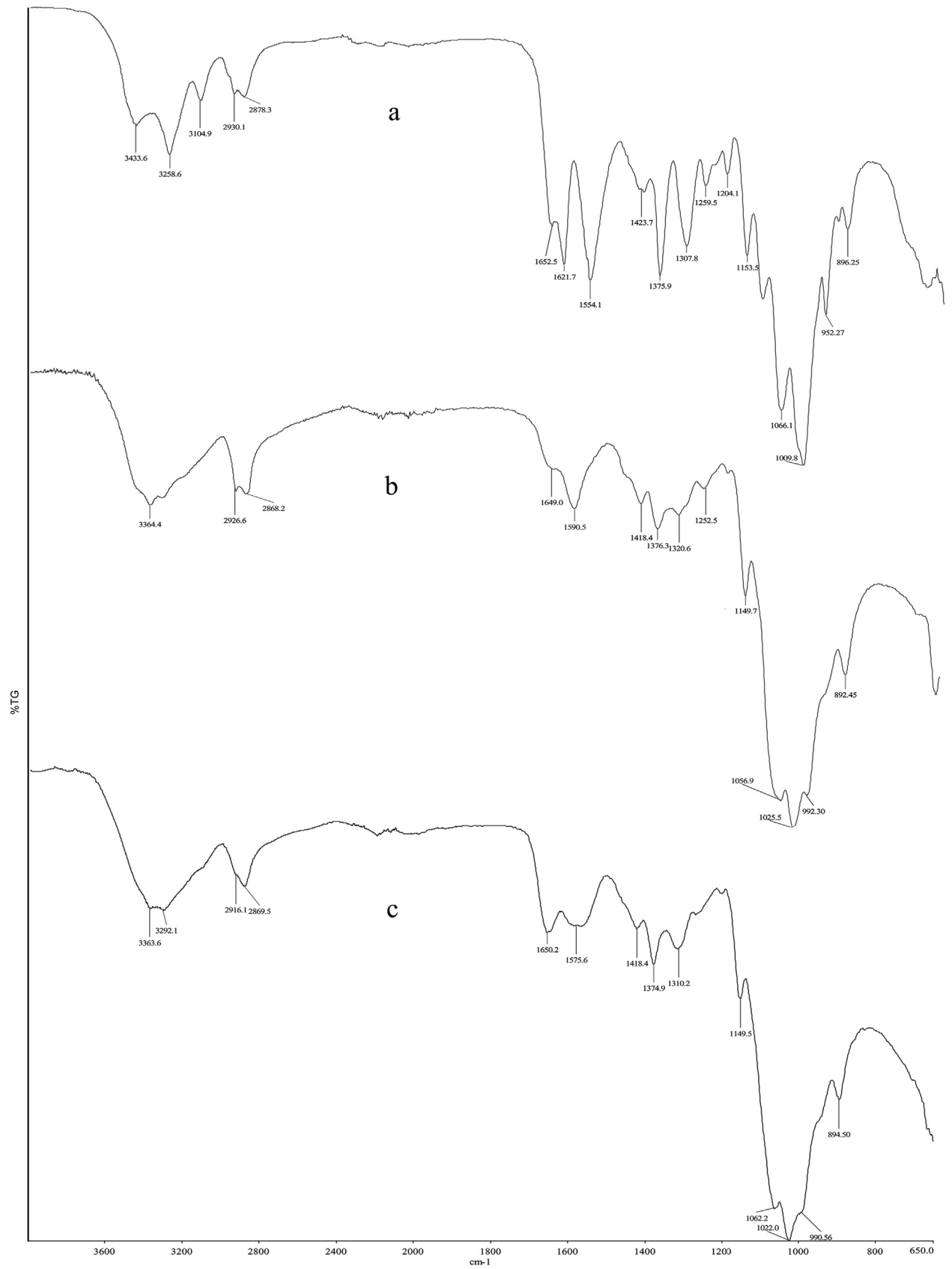

FIG. 1. FTIR spectra of chitin and chitosan samples. (a) Chitin from scorpion, (b) chitosan from scorpion, (c) commercial chitosan.