Antimicrobial effect of turmeric (Curcuma longa) on chicken breast meat contamination

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ABSTRACT

The aim of this study was to evaluate the efficacy of turmeric (*Curcuma longa*), also known in Brazil as saffron, on the reduction of *Staphylococcus aureus* and *Escherichia coli* counts in chicken meat. Forty breast meat samples were divided in two groups (A and B). In group A, 10^3-10^4 *E. coli* (ATCC 25922) cells were inoculated and group B samples were inoculated with 10^4-10^5 *S. aureus* (ATCC 9801) cells, after which each group was divided in three samples. The first sample was analyzed immediately after inoculation. The second sample (control group) was stored at 4 ºC for 48 hours and turmeric at 1% (w/w) was added to the third sample, which was homogenized and then stored under the same conditions as the second sample. *E. coli* and *S. aureus* were enumerated in all samples. Mean bacterial counts determined for the control samples and for the samples with turmeric addition after 48h of storage were 1.83 x 10^4 CFU g^{-1} and 1.80 x 10^4 CFU g^{-1} for *S. aureus*, and 9.36 x 10^3 CFU g^{-1} and 7.25 x 10^3 CFU g^{-1} for *E. coli*, respectively. The results showed that there was no significant reduction in bacterial counts with the addition of 1% turmeric to chicken breast meat.

INTRODUCTION

The microbial contamination of foods is an important public health concern, and consequently, it is also influences economy. The poultry industry, for instance, faces difficulties in the control of the contamination of broiler carcasses, which negatively influences food safety and reduces food shelf life (Capita *et al*., 2001).

Different pathogens have been isolated from chicken meat and have been involved in foodborne diseases, such as *Escherichia coli (*Moreira *et al*., 2005) and *Staphylococcus aureus* enterotoxin (Freitas *et al*., 2004). Consequently, chemical preservatives have been increasingly used in the processing industry to control microorganism levels in foods.

On the other hand, consumers have demanded from the food companies the application of practices to reduce the levels of chemical additives in food products, as many food preservatives have harmful side effects, including carcinogenic activity (Moreira *et al*., 2005). This has led to the search of natural alternatives for food preservation, minimizing consumers' health hazards (Souza *et al*., 2003).The study and assessment of antimicrobial activity in natural products, such as spices, have been stimulated with the aim of finding new options for the replacement of chemical preservatives to control the growth of foodborne pathogens (Coutinho *et al*., 2003).

An alternative to minimize poultry carcass contamination and that also functions as a condiment and enhances meat appearance and its acceptance in the market is the use of turmeric. Bara & Vanetti (1992) reported that turmeric inhibited the development of pathogenic

microorganisms, suggesting that its use in broiler carcasses may, in addition of providing it with a desirable yellow color, it may reduce carcass contamination by pathogenic microorganisms. Experiments show that a turmeric compound called curcumin is capable of inhibiting carcinogenesis (Chuang *et al.*, 2000).

Therefore, this study aimed at evaluating the efficacy of turmeric in the reduction of *Escherichia coli* and *Staphylococcus aureus* counts in chicken breast samples.

MATERIALS AND METHODS

Location and procedures

The experiment was carried out at the Applied Animal Biotechnology Laboratory (Laboratório de Biotecnologia Animal Aplicada – LABIO) of Universidade Federal de Uberlândia, state of Minas Gerais, Brazil.

Forty chicken meat samples were acquired at a local retail store, divided in two groups, and experimentally contaminated with 10^3-10^4 cells of *Escherichia coli* ATCC 25922 (group A) and 10^4-10^5 cells of *Staphylococcus aureus* ATCC 9801 (group B).

Meat was cut in small pieces and samples weighing 400g were then contaminated with the inoculum diluted in 5mL sterile NaCl solution at 0.9%. Samples and inocula were homogenized for five minutes. After contamination, groups A and B were aseptically divided, using laminar flow, in three samples weighing approximately 100g, which were then identified and individually placed in sterile polyethylene bags. Sample 1 was immediately analyzed for *E. coli* and *S. aureus* enumeration, and sample 2 (control group) was stored

under refrigeration (4°C) for 48h. One percent (w/w) turmeric was added to sample 3 (test group), which was then homogenized, and stored under the same conditions as subsample 2. After the storage period, samples 2 and 3 were analyzed for *E. coli* and *S. aureus* enumeration.

Results were analyzed according to an individualized block experimental design, with two treatments of five replicates, totaling 40 experimental units. Microbiological counts were submitted to analysis of variance and means were compared by the test of Tukey (Triola, 1999).

Inoculum standardization

The inoculum was standardized by monitoring during several incubation periods. Optical density at 650nm (OD_{650nm}) was correlated with the number of colony-forming units ($CFUg^{-1}$), using a regression equation by means of the software program MicroCal ORIGIN 4.0 (1995). The equation was used to predict and to standardize the number of inoculated cells.

Microbiological analyses

Out of each sample, 25g were analyzed. Samples were added to 225mL buffered peptone water at 0.1% (BPW), which was considered 10^{-1} dilution, based on which serial dilutions in BPW were performed. *Escherichia coli* ($CFU.g^{-1}$) and *Staphylococcus aureus* ($CFU.g^{-1}$) were then enumerated using the Simplate chromogen method (Franco & Landgraf, 1996) and inoculation in Baird Parker agar (ABNT, 1991), respectively.

A) Log UFCg^{-1}

r^2=0,99931
y=4,10137+48,51792x

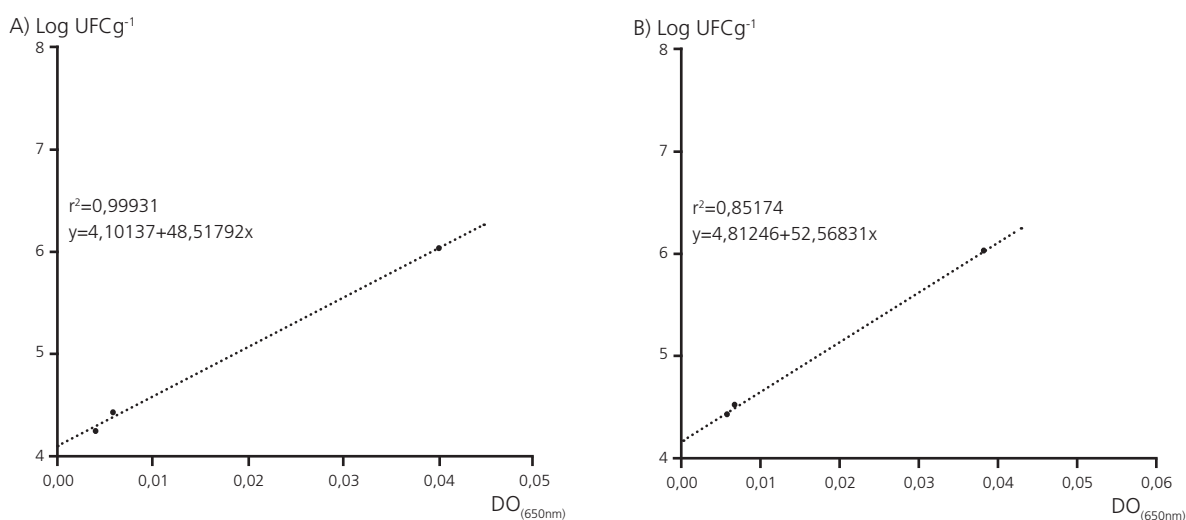B) Log UFCg^{-1}

r^2=0,85174
y=4,81246+52,56831x

Figure 1. Regression equation, graph, and coefficient of correlation for *Escherichia coli* ATCC 25922 (A) and *Staphylococcus aureus* ATCC 9801 (B) obtained by optical density at 650nm (OD_{650nm}) and $CFUg^{-1}$ logarithm.

RESULTS AND DISCUSSION

The results obtained for optical density at 650nm (OD_{650nm}) and colony-forming units ($CFU g^{-1}$) of *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 9801 were used to build the regression equation and graph (Figure 1 - A and B).

Sample 1, immediately after inoculation, presented *Escherichia coli* ATCC 25922 counts between 7.4 x 10^3 CFU g^{-1} and 2.1 x 10^4 CFU g^{-1}, and *Staphylococcus aureus* ATCC 9801 counts between 2.3 x 10^4 CFU.g^{-1} and 1.1 x 10^5 CFU g^{-1} (Table 1).

Table 1 - *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 9801 counts in chicken breast meat immediately after inoculation.

Replicate	CFU g^{-1} calculation	
	E. coli ATCC 25922	*S. aureus* ATCC 9801
1	1.1 x 10^4	5.0 x 10^4
2	7.4 x 10^3	9.7 x 10^4
3	2.0 x 10^4	2.3 x 10^4
4	2.1 x 10^4	1.1 x 10^5
5	2.0 x 10^4	9.5 x 10^4

The obtained counts indicate the applied calculations were adequate for the artificial contamination of chicken meat samples with *E. coli* and *S. aureus.* These results are in agreement with the recommendations of Jorge *et al*. (1990) of using a regression equation (OD *vs.* CFU.g-1) as a tool to standardize experimental inocula.

Mean *Staphylococcus aureus* counts determined in samples of the control group and of the test group were 1.83 x 10^4 CFU g^{-1} and 1.80 x 10^4 CFU g^{-1}, respectively. These counts indicate that the use of turmeric did not reduce (p>0.05) *S. aureus* contamination after 48h of contamination. These results are presented in Table 2.

Table 2 - *Staphylococcus aureus* and *Escherichia coli* counts ($CFU.g^{-1}$) in chicken breast meat with the addition or not of 1% turmeric in after refrigeration at 4°C for 48 hours.

Replicate	*S. aureus* count		*E. coli* count	
	No turmeric	With turmeric	No turmeric	With turmeric
1	2.0 x 10^4	1.9 x 10^4	8.4 x 10^3	4.8 x 10^3
2	1.9 x 10^4	2.2 x 10^4	4.4 x 10^3	8.6 x 10^2
3	1.4 x 104	1.5 x 10^4	1.7 x 10^4	1.2 x 10^4
4	2.6 x 10^4	1.6 x 10^4	7.0 x 10^3	5.0 x 10^3
5	1.3 x 10^4	1.8 x 10^4	1.0 x 10^4	1.4 x 104
Mean counts in CFU.g^{-1}	1.83 x 10^4a	1.80 x 10^4a	9.36 x 10^3a	7.25 x 10^3a
Mean counts in log^{10}	4.249774 a	4.251332 a	3.929994 a	3.705486 a
Coefficient of variation (%)	2.32		9.71	

a Means followed by the same letter in the same row are not statistically different

(p>0.05) CFU.g^{-1}: colony-forming unit per gram

Ferreira (2003) also did not observe any significant reduction in *S. aureus* counts in cottage cheese samples treated with powdered turmeric at 0.2%, 0.4%, 0.8%, or 1.0% However, when 2.0 to 6.0% were used, an antimicrobial effect was detected. On the other hand, Franco *et al*. (2007) evaluated the possible antimicrobial effect of *Curcuma longa* L. essential oil on *Staphylococcus aureus* ATCC 6538, *Escherichia coli* O:158 and *Salmonella choleraesuis* ATCC 10708 growth using agar diffusion, and verified that only *S. aureus* ATCC 6538 growth was inhibited. Those authors suggested that turmeric may specifically act against Gram-positive bacteria.

There was no influence (p<0.05) on the addition of turmeric to the chicken breast meat samples on *E. coli* counts in the present experiment. Mean *E. coli* counts obtained in samples without or with turmeric addition were 9.36 x 10^3 CFU. g^{-1} and 7.25 x 10^3 CFU.g^{-1}, respectively, as shown in Table 2.

According to Shelef (1980), the concentration of turmeric required to inhibit bacterial growth is between 1 and 5%, which may explain the lack of effect on *E. coli* and *S. aureus* in the present experiment, where low turmeric concentration was applied. Moreover, this concentration was not sufficient to inhibit the high number of microorganisms (10^4) inoculated. However, considering that the typical levels of turmeric used to enhance food flavor and aroma are in the range of 0.5 to 1%, higher levels may impair consumer acceptance. Therefore, the optimal turmeric concentration, which simultaneously has antimicrobial and flavor enhancement effects, needs to be determined.

Because turmeric components are nonpolar and chicken meat is rich in water and not in fats the applied turmeric powder did not present proper solubility, which may have influenced its antibacterial action.

CONCLUSIONS

The growth of *Staphylococcus aureus* and *Escherichia coli* was not inhibited in chicken meat breasts treated with 1% powdered turmeric.

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