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Note

CALORIMETRIC MEASUREMENTS ON INHIBITORY EFFECTS OF GARLIC ON SOME MEATS

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Antimicrobial effects of garlic (*Allium sativum*) have been studied by many workers who have found that garlic extract inhibited the growth of many bacteria and fungi. In the more recent investigations, Saleen et al. [1] have shown that aqueous extracts from fresh garlic bulbs inhibited the growth of *Bacillus cerus* on nutrient agar plates, Mantis et al. [2] reported that a 5% garlic extract concentration had a germicidal effect for *Staphylococcus aureus* in culture media, Karaioannoglou et al. [3] showed that garlic extracts at higher than 1% were inhibitory to *Lactobacillus plantarum* and Conner et al. [4] screened 32 essential oils from plants for inhibitory effects on 13 food spoilage and industrial yeasts, of these garlic oil was a potent inhibitor of yeast growth. For the above investigations, however, the general but tedious agar plate method was used.

In our earlier paper [5] dealing with the calorimetric measurements on food spoilage, it was shown that the heat evolution caused by putrefaction was proportional to the growth of bacteria, and it was suggested that the calorimetric measurement would be a useful tool for studies on food spoilage. Takahashi et al. [6–8] also presented a quantitative method to determine antimicrobial effects of preservatives on food spoilage by calorimetric measurements.

The present investigation was undertaken to determine the effects of the inhibition of garlic on the spoilage of chicken and pork by calorimetric measurements.

EXPERIMENTAL

Blocks of commercial pork and chicken were minced and divided into 10 g samples and after wrapping with the polyvinylidene chloride film, quickly frozen and kept at – 30 °C. For experiment, the frozen meats were thawed at 30 °C and mixed with ground fresh garlic bulbs, then set in a cell of a

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twin conductive microcalorimeter (Tokyo Riko Model TCC-21). The symmetrical twin cells are in an aluminum block that has a large thermal capacity. One of the cells is for the reference, which is water of the same weight as the meats, and the other is for the sample meat. After the system had reached thermo-equilibrium at 30 °C (about 2 h were needed), the measurements were started.

Because the calorimeter is a conductive rather than an adiabatic type, an exotherm coincides with cooling. If we define g(t) as the observed temperature change, at time t in a calorimeter, and f(t) as the temperature change of thermal process, we obtain the following equation:

$$\frac{\mathrm{dg}(t)}{\mathrm{d}t} = \frac{\mathrm{df}(t)}{\mathrm{d}t} - k\mathrm{g}(t) \tag{1}$$

where k is the cooling constant of the system. Integration of eqn. (1) gives:

$$\mathrm{f}(t) = \mathrm{g}(t) + k\int \mathrm{g}(t)\,\mathrm{d}t + g_0 \tag{2}$$

where g_0 is an integration constant which is reduced to zero by the nature of the problem.

As phenomena of food spoilage are very complex because of the occurrence of many types of microorganisms, the thermograms obtained are complicated. In these experiments, we estimated the thermograms by the observed temperature change, g(t).

RESULTS AND DISCUSSION

Antispoilage effects of ground garlic on minced chicken and pork

From zero to 20% of the ground garlic was added to 10 g of minced chicken and pork, well-mixed and set in the calorimeter cell. As a reference, the same quantity of distilled water was used. The thermograms of spoilage of the meats at 30 °C are shown in Fig. 1.

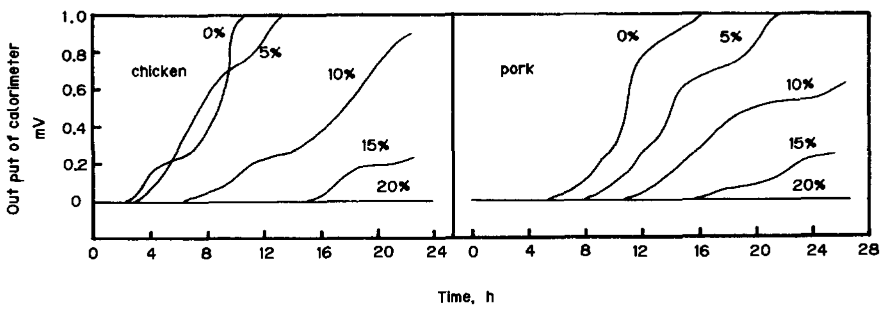

Fig. 1. Thermograms of spoilage of chicken and pork. Percentages in the figure show the concentration of ground garlic in minced chicken and pork.

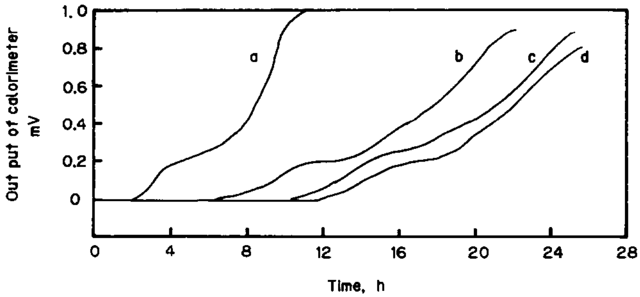

Fig. 2. Thermograms of spoilage of chicken adding 5% garlic from different geographic origins: a, without garlic; b, Japanese ground garlic; c, American ground garlic; d, Chinese ground garlic.

Heat evolution in the putrefaction of chicken without adding the garlic was found at about 2 h and that of pork was revealed at about 6 h after preparing the samples. It is clear that the ground garlic inhibited heat evolution; the more garlic was added, the greater was the increase in inhibition. Heat evolution was totally inhibited when garlic reached 20% of the mixture. The figure also shows that the lag phases of the heat evolutions were elongated by increasing the garlic concentration. In our earlier paper [5], it was shown that the degree of the heat evolution shows the degree of the growth of bacteria: the ground garlic inhibiting the spoilage of the meats. However, the smell and color of the meats were greatly changed by the addition of garlic over 10%.

Comparison of antispoilage effect of different sources of garlic

In general, plants from different sources vary in the amounts of certain components. Thus, the antispoilage effect of different garlics should differ from each other.

Five percent of the ground Japanese, Chinese and American garlics were individually mixed with 10 g of the minced chicken at 30 °C. The thermograms with spoilage are shown in Fig. 2. The figure shows that Chinese and American garlic inhibited spoilage more effectively than the Japanese. It is generally known that the allicin in garlic is a major antimicrobial substance. Thus, it can be surmised that the allicin content in Chinese and American garlic could be higher than that in Japanese ones.

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