

Short Communication

Safety of vegetarian meat analogs and their natural meat products using somatic mutation and recombination test

Narukorn Wanut, Kaew Kangsadalampai and Kalyarat Kruawan*

Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon 4, Nakhon Pathom 73170 Thailand.

*Email: kalyarat.kru@mahidol.ac.th

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Abstract

Four items of meat analogs and four natural meat product counterparts were investigated for their modulation effects on the somatic mutation and recombination of chromosomes in *Drosophila melanogaster* induced by urethane (URE). Trans-heterozygous (*mwh flr⁺/mwh TM3*) larvae were transferred to the experimental medium for mutagenicity study. The experimental media were made from regular medium containing each meat analog or meat product counterpart substituted for 60% w/w of the whole ingredients (corn flour, yeast and sugar). In addition, the larvae were transferred to the experimental medium containing URE as antimutagenicity study. Until they became adult flies, the wings were analyzed for the mutant spots. The findings revealed vegetarian sausage, vegetarian salted fish and sausage meat products had mutagenic potential, other meats had no such results. Both sausages containing amines (in natural meat, soy flour or spices) and nitrite to form nitrosamines showed their mutagenicity. The antimutagenicity (%) of meat analogs, namely vegetarian sausage, vegetarian *sai-oua*, vegetarian meatball and vegetarian salted fish were 65.7%, 36.15%, 65.04%, 36.94%, respectively. The antimutagenicity (%) of natural meat products, namely sausage, *sai-oua*, meatball, salted fish were 54.22%, 33.91%, 31.93%, 60.95%, respectively. All meat analogs showed protective effects against URE since they contain isoflavones as key nutrients. The metabolites of URE were detoxified by conjugation with glutathione using glutathione-S-transferase. It is possible that the presence of isoflavones may be due to inducing of glutathione-S-transferase activity. Furthermore, all natural meat products showed their protective effects against URE as well since they contain cysteine and methionine as needed for maintaining the levels of glutathione as well as glutathione-S-transferase synthesis.

Keywords: mutagenicity, antimutagenicity, SMART, *sai-oua*, sausage, salted fish, meatball, Thailand.

Introduction

Meat analogs are usually made from soy protein or wheat gluten. In addition, ingredients including flavours, odors, herbs, spices and edible adhesives are added as well. However, the most common imitation meat flavourings commercially available are hydrolyzed vegetable proteins, which are offered as single products or blended with spices and/or flavour potentiators (e.g. ribonucleotides and monosodium glutamate). Therefore, the meat-like flavour is a blend of synthetic materials, or a blend of synthetic and natural materials that are compounded to stimulate known flavours. It is certain that reactions involving more complicated systems will yield a larger number of compounds with the possibility that some may be carcinogenic or mutagenic.

Materials and Methods

Sample preparation

Meat analogs, namely vegetarian sausage, vegetarian *sai-oua* (pork sausage, northern Thai style), vegetarian meatballs and vegetarian salted fish and their meat product counterparts, namely sausage (pork), *sai-oua*, meatball (pork) and salted fish were purchased from supermarkets in Bangkok. All test samples were homogenized in an electric blender.

Somatic mutation and recombination test (SMART)

The test was performed as described by Graf *et al* [1]. Trans-heterozygous (*mwh flr⁺/mwh TM3*) larvae were transferred to the experimental medium for mutagenicity study. The experimental media were made from regular medium containing each sample substituted for 60% w/w of the whole ingredients (corn flour, yeast and sugar). In addition, the larvae were transferred to the experimental medium containing URE as antimutagenicity study. Until they became adult flies, the wings were analyzed for the mutant spots. The antimutagenicity (%) of each sample was determined by the following equation:

$$\text{Percentage of antimutagenicity} = ((a-b)/a) 100$$

When *a* is the frequency of spots induced by URE alone and *b* is the frequency of spots induced by URE in the presence of sample.

Results

Mutagenicity

Figure 1 shows the effectiveness of each sample on their mutagenicity in different categories of mutant spots. It is suggested that sausage, veggie sausage, salted fish and veggie salted fish increased the frequency of wing spots. None of the other samples significantly increased mutant spots to be higher than that of negative control.

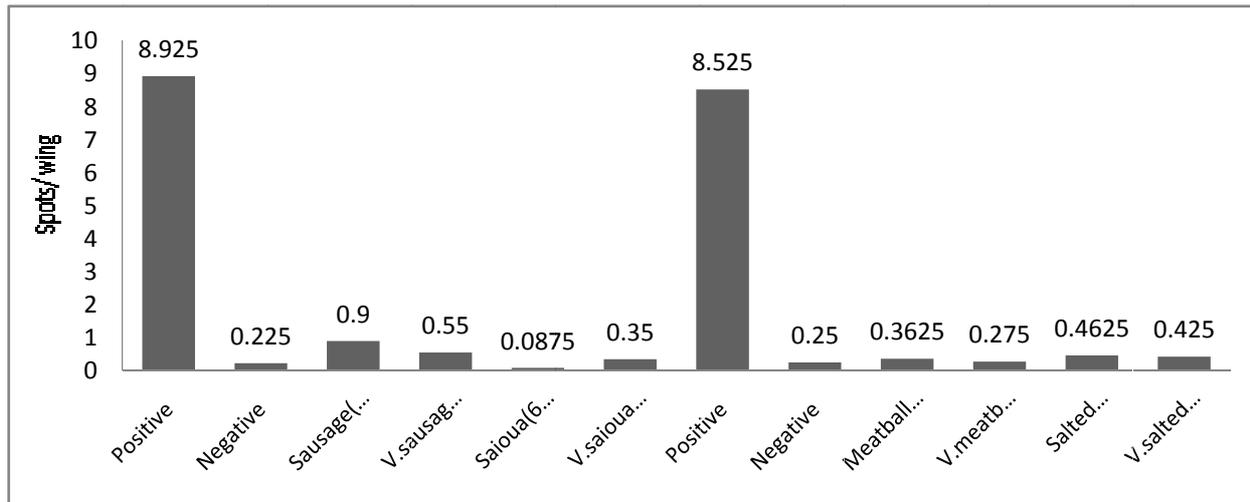


Figure 1. Overview (spots/wing) of each sample showing their mutagenicity.

Antimutagenicity

Both meat analogs and meat products reduced mutant spots induced by URE (Figure 2). The results revealed that meat analog, namely, vegetarian sausage, vegetarian *sai-oua* and vegetarian meatball, were better antimutagens than their meat product counterparts.

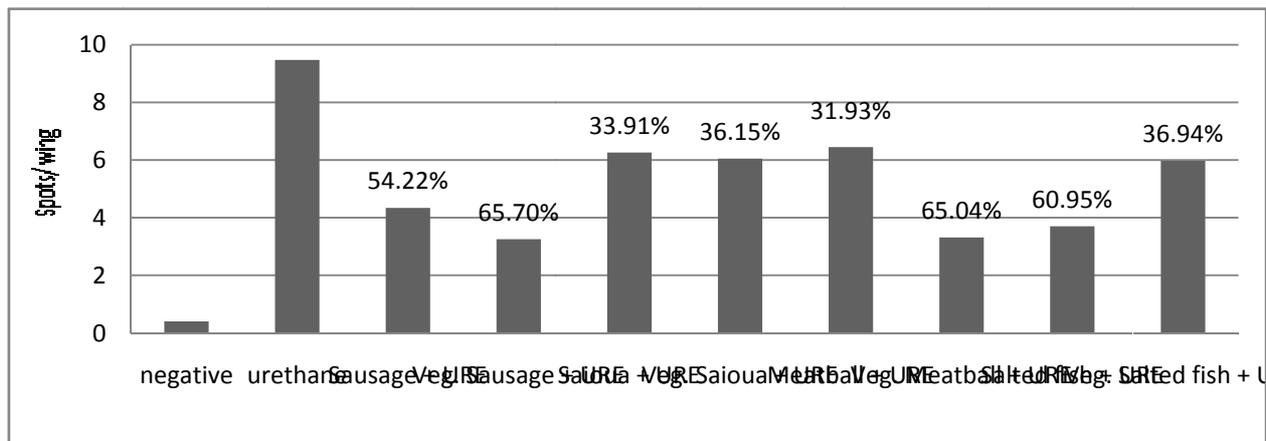


Figure 2. Overview (% antimutagenicity) of each sample on URE mutagenicity in *Drosophila melanogaster*.

Discussion

Mutagenicity

Sausage and vegetarian sausage analog expressed their mutagenicity. Sausage is one kind of cured meat product with which nitrite salt-spices are used. Rojas-Campos [2], showed that nitrite salt increased the mutagenicity of nitrosated food and some amines in the sausage ingredients as well as in spices may react with nitrite to form nitrosamines. The mutagenicity potential of salted fish and vegetarian salted fish has been revealed. High salt content may play a role in the presentation of mutagenicity in such samples. Choen and Roe [3], reported that high sodium chloride intake weakly increased DNA single-strand and double-strand breaks in mammalian cells.

Antimutagenicity

Meat analogs decreased the frequency of spots induced by URE. It is possible that the antimutagenic effect of meat analogs may be due to inducing of GST activity. Park, *et al* [4], demonstrated that the metabolite of URE was detoxified by conjugation with glutathione (GSH) using glutathione-S-transferase (GST) [5]. Meat analogs are soy-based food. Mirsalis, *et al* [6], reported that soy bean flakes increased the activities of GST. In addition, antimutagenic effect of meat analogs may result from the effects of some components of soy proteins (genistein and equol) reducing the activities of CYP-450 enzymes leading to a reduction of bioactivation of URE. In meat products, sausage, *sai-oua*, meatball and salted fish decreasing the frequency of spots induced by URE may be due to the fact that each sample increased GSH concentration. Generally, animal meat contains a high level of cysteine and methionine to maintain optimal GSH levels for efficient phase II detoxification [7]. In addition, herbs and spices are always used to mask the off-flavour of meat products. Tadi, *et al* [8], found that garlic extract increased GSH to detoxify the metabolites of AFB₁. Lemon grass enhanced GST activity in mouse intestinal cells [10].

References

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