

Effect of heat treatment on the antimicrobial properties of *tef* dough, *injera*, *kocho* and *aradisame* and the fate of selected pathogens

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A known population from each of a 24 h culture of *Bacillus cereus*, *Pseudomonas aeruginosa*, *Salmonella* spp., *Shigella* spp., *Klebsiella* spp. and *Staphylococcus aureus* was inoculated into *tef* flour–water/*kocho*–water mixtures in screw-capped flasks and allowed to ferment for 30 h at room temperature (18–21 °C). The flasks were then heat-treated. Cultures of the test bacteria were inoculated into tubes containing graded volumes of 30-h-fermented *tef* dough/*kocho* extracts which had been heat-treated at 45, 61 and 80 °C in assay broth containing aqueous extracts from *injera* and *aradisame*. They were incubated for 24 h at 32 °C and optical densities determined. Populations of the major indigenous bacteria, yeasts and moulds in fermented *tef* dough (30 h), *kocho* samples, *injera* and *aradisame* were determined from other control portions of the same samples. Higher temperature (80 °C) heat-treatment promoted the inhibitory potential of extracts from doughs of both foods as compared with lower temperature heat-treatments (45 and 61 °C). Asporogenous test bacteria were affected more than the spore-formers. Better efficacy of extracts from *injera* and *aradisame* suggested improved antimicrobial properties of the baked products than in doughs. Heat of baking inactivated all vegetative cells although spores of *B. cereus*, the yeasts and moulds survived the heat (100 °C) applied for 5 min. The c.f.u./g of food for *B. cereus* was below the disease-causing level (0.5×10^1 and 1.5×10^3 , in *injera* and *aradisame*, respectively). Actual baking temperatures in homes are higher than the ones used here; if post-baking contamination is minimized or prevented, the products would be microbiologically safe with respect to the asporogenous pathogens when served fresh. Further studies on aflatoxins and improved storage conditions for *kocho* are recommended.

Key words: Aradisame, baking heat, *Enset ventricosum*, *Eragrostis tef*, inhibition, *injera*, *kocho*, lactic acid fermentation, *tef* dough.

In Ethiopia, there are many types of traditional fermented foods amongst which *injera* and *kocho* (*Ensete ventricosum*) are two major staples. *Injera* is unleavened bread usually prepared from fermented cereal flour, such as *tef*, wheat, barley, maize, sorghum, millet or composite flour of these cereals. *Injera* from *tef* (*Eragrostis tef*) is much more (about three times) relished, by most Ethiopians, than that from any other source (ICNND 1959). Over 12 million people, mainly living in southern and

south-western regions of the country, are known to depend on *kocho* as a sole carbohydrate source. *Aradisame* (unleavened bread) is the commonest diet baked from *kocho* and served to almost all age groups mainly in rural and urban settings of *Enset*-growing areas. *Kocho* has also become a common food in towns and cities in central Ethiopia (A. Nigatu, unpublished work).

Both *injera* and *aradisame* are baked from fermented substrates; fermentation of *tef* dough takes 2–4 days and that of *kocho* requires weeks to months. The former is fermented, in homes, in earthen, metallic, plastic or wooden vessels with the top covered, and the latter is commonly fermented in an airtight silo prepared usually in the backyard *enset* garden. *Kocho*, even after completing its fermentation, is stored in such underground pits for years.

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