MEAT-BASED MODEL SYSTEM FOR FERMENTATION STUDIES

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SUMMARY

The simulation of raw meat fermentation attempts to deal with difficulties related to solid-state fermentation systems. A liquid model-system was devised using pork, beef, sucrose, glucose, manganese, phosphates and nitrite. Refrigerated lean pork tender loin and beef topside were minced, vacuum packed in double layer plastic bags and irradiated to 4.5 kGy by the submersion technique. A solution was prepared with salt, sugar, and water ingredients and sterilized by autoclaving at 121°C for 15 min. The cold meat (5°C) was mixed with the cold (4°C) salt solution and homogenized in a Waring blender. Filter sterilized nitrite solution was added to the medium to a final concentration of 100 ppm immediately before inoculation. The pH, buffering capacity (ß),and a_w of the particulate medium were simulations of those found in a salami mix. Pediococcus sp. CCM 822, P. pentosaceus NCFB 1220, P. pentosaceus NCFB 559, and two commercial strains (Chr. Hansen's P. pentosaceus and Lactobacillus plantarum) were subcultured as axenic cultures into the liquid system and showed similar pattern of growth compared to laboratory-prepared salami mix. Similar results were also observed with a cocktail culture of Staphylococcus aureus strains. A further development to allow simulation of water losses during early stages of fermentation was tested against those strains and commercial cultures of Lactobacillus sake and L. alimentarius. The pH profiles were similar in both media.

INTRODUCTION

The homogeneous mixing of ingredients and a more uniform distribution of inoculated microflora are points of vital importance in fermentation studies and are attained more readily in liquid substrates.

Sausage is a complex colloidal system with physical properties influenced by buffer capacity, aeration, a_w, adsorption of metabolites, and availability of nutrients. Its properties vary continuously during maturation in a somewhat integrated chain of processes. Microbial population, nitrite, a_w, and pH are some of the varying parametes. All these make it difficult to replicate in the laboratory environment the precise conditions and responses of a full set of processing operations.

A wide range of different substrates and set of conditions have been used by several workers to obtain simulated responses to processing conditions. A number of workers used sausage mixes based on pork or beef (Olsen & Peitersen, 1986), or varying amounts of both (Niskanen & Nurmi, 1976; Raccach, 1986). Others used ham (Genigeorgis et al., 1969), agar-meat sausages (Smith & Palumbo, 1980), or beef slurry (Olsen & Peitersen, 1986). Some even heat-treated the meat substrate (Genigeorgis et al., 1969).

The design of a suitable liquid-meat system to enable simulating processing responses has to consider basic principles such as (1) the nature and function of the ingredients contained in the substrate to be replaced, (2) the replacement medium must have

the ability to support the growth of the target microflora comparable to the medium being replaced, and (3) aw, pH and buffer capacity (ß).

MATERIALS AND METHODS

1. Formulation: the starting point to design the medium were the meat quantities used by Brazilian salami processors (Table 1). Similar criteria was used to calculate concentrations of salt and sugar in water phase. The ratio of meat to water necessary to result in a medium of good handling and consistency was empirically set at 1:9.

2. Meat: refrigerated lean pork tender loins and beef topside from retail supplier were further trimmed in laboratory, minced and vacuum packed in double layer plastic bags. These bags were irradiation-treated at 4,5 kGy by submersion technique. The irradiated meat was stored in freezer (-20°C) until use when bags were left overnight at 5°C as defrost procedure.

3. Sugar and salts: NaCl (5.27%), sucrose (1.0%), glucose (0.43%), $MnSO_4$ (0.005%), Na_2HPO_4 (0.56%) and $NaH_2PO_4.2H_2O$ (0.79%) were dissolved in water and autoclaved at 121°C for 15 min, and stored refrigerated until required. A nitrite solution was prepared by solubilizing 0.21 g of $NaNO_3$ in 100 g of sterile salt-sugar solution and filter-sterilized immediately before use.

4. Preparation of the medium: pork and beef (68 g and 21 g, respectively) were asepticaly transferred to a sterile Waring blender. Salt-sugar solution was added (769.93 g) and mixing done for 45 sec. The medium was dispensed into universal-type bottles in amounts of 19 g using fast-flow pipettes.

5. Assessment of the liquid-meat system: buffer capacity (ß) was determined according to Wilson & Goulding (1986). Water activity was determined in a Novasin Thermoconstanter a_w-meter and pH in a EIL 7030 pH-meter. The medium was also tested for growth response by inoculating separately Pediococcus sp. CCM 822, P. pentosaceus NCFB 1220, P. pentosaceus NCFB 559, P. pentosaceus CH (PEDIOSTART) and Lactobacillus plantarum CH (LACTOSTART). One set of cultures was prepared by inoculating a cocktail of 9 strains of Staphylococcus aureus. All cultures were also inoculated in laboratory prepared salami-mix. The set of temperatures for incubation simulated salami processing. Growth was determined by surface counts on MRS or Baird-Parker Agar.

6. Simulation of water loss during fermentation: the NaCl content was further increased by adding an aliquot containing 0.106 g salt in each bottle of 19 g of media to simulate the depression on a_w due to water losses after 48 h fermentation period. Such procedure was tested by determining the pH profiles of Lactobacillus sake and L. alimentarius.

RESULTS AND DISCUSSION

Table 2 gives an account of the composition and main physico-chemical parameters of the liquid meat system and laboratory-prepared salami mix. The liquid medium was easier to handle and could be prepared in batch for use over longer periods.

All cultures tested showed good growth in the liquid medium compared to salami mix (Fig 1 to 3). The slightly better growth in the liquid medium may be due to a larger contact area between the bacteria and nutrients, coupled with a quicker and more efficient dispersion of metabolites produced. The medium also allowed good reproducibility of results (Fig. 4 to 6).

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TABLE 1: Formulation for salami processing.

INGREDIENTS	QUANTITY (kg)	RANGE (kg)
Pork (prime cut)	64	48-80
Beef (prime cut)	19.7	0-28
Pork backfat	11	10-19
Salt	3.9	3-4.3
Glucose	0.3	0.3-1.0
Sucrose	0.7	0-1.0
Garlic (paste)	0.17	(?)
Nutmeg	0.02	(?)
White pepper	0.1	(?)
Nitrite	90 ppm	(?)
Nitrate	120 ppm	(?)

TABELA 2: Composition and main physico-chemical parameters of the liquid meat system and salami mix.

INGREDIENTS	MEAT SYSTEM (?)	SALAMI MIX (?)
Pork	7.09	72
Beef	2.19	22
NaCl*	5.2	4.4
Sucrose*	0.9	0.8
Glucose*	0.39	0.4
$MnSO_4$*	0.004	0.005
Na_2HPO_4*	0.5	-
$NaH_2PO_4.2H_2O$*	0.71	-
H_2O	83.4	-
$NaNO_3$•	100 ppm	100 ppm
pH	5.85	5.8
a_w	95.4	95.6
ß	0.8	0.83

* In water phase