DEVELOPMENT AND PREDICTIVE MODELLING OF SET YOGHURT AS A MADE-IN-TRANSIT (MIT) PRODUCT

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ABSTRACT

The manufacture of food during distribution, a concept known as "made-in-transit" (MIT) manufacture, has the potential to expand the distribution reach, extend shelf-life, and provide the customer with the freshest possible product. Benefits for the manufacturer include maximising throughput while minimising manufacturing space and inventory. This concept is new, with mushrooms being the only MIT food developed so far. In this study, the feasibility of developing an MIT product from a fermented food was determined using set yoghurt as a model system. An MIT yoghurt was developed through the alteration of some of the yoghurt manufacturing parameters (e.g. milk base formulation, heat treatment, starter culture composition and fermentation temperature), extending the yoghurt fermentation time from about 4 h to 168 h (7 days). It was found necessary to fortify the milk base (reconstituted skim milk powder) with a suitable protein-containing dairy ingredient (sodium caseinate and milk protein concentrate were found best) to rectify the poor texture of the resulting yoghurt. Descriptive testing and acceptance testing using trained and consumer sensory panels, respectively, showed that MIT yoghurts were significantly different from conventionally made yoghurt, but were more acceptable. The yoghurts were found to have adequate shelf lives post fermentation, partly owing to the use of ultra-high temperature (UHT) sterilization of the yoghurt milk base prior to inoculation to ensure the absence of starter bacteria competitors. As the production of MIT yoghurt involves a relatively long, temperature dependent fermentation, it was considered useful to develop models for predicting the effects of both time and temperature on such dependent variables as starter bacteria count, pH, and firmness. A predictive microbiology approach was taken. The modified Gompertz equation was found to model adequately the time dependence of starter bacteria growth and firmness development during fermentation, while the modified logistic equation was found adequate for modelling pH decline. These two equations are primary models, whose parameters were then related to temperature using the square root (Ratkowsky) equation as a secondary model. Combination of the primary and secondary models provides means of predicting the effects of both time and temperature simultaneously. Comparison of predictions with data generated in extrapolation and interpolation experiments proved the efficacy of the models.

The work described in this thesis demonstrates the potential of the MIT concept for a fermented food. The concept could be applied to many fermented foods.

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ABBREVIATIONS

λ	Lag phase
μ_{max}	Maximum growth
BMP	Buttermilk powder
CCP	Colloidal calcium phosphate
cfu	Colony forming unit
g	gram
h	hour
HTLT	High temperature long time
MIT	Made-in-transit
mL	millilitre
mmol	millimoles
MPC	Milk protein concentrates
NaCN	Sodium caseinate
SMP	Skim milk powder
STLA	*Streptococcus thermophilus* STM5 and *Lactobacillus acidophilus* LA5
STLB	*Streptococcus thermophilus* STM5 and *Lactobacillus delrueckii subsp. bulgaricus*
STLC	*Streptococcus thermophilus* STM5 and *Lactobacillus casei*
UHT	Ultra-high temperature
WMP	Whole milk powder
WPC	Whey protein concentrates
WPD	Whey protein denaturation

LIST OF PUBLICATIONS

Nor-Khaizura M-A-R, Flint SH, McCarthy OJ, Palmer JS, Golding M, Jaworska A (2012). Development of made-in-transit set culture yoghurt: effect of increasing the concentration of reconstituted skim milk as the milk base. International Journal of Food Science & Technology 47 (3):579-584. doi:10.1111/j.1365-2621.2011.02880.x

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