



UNIVERSITEIT VAN PRETORIA  
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# **Fermentation of a finger millet-dairy composite gruel**

by

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## ABSTRACT

### FERMENTATION OF A FINGER MILLET-DAIRY COMPOSITE GRUEL

by

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Fermentation is widely used in Africa to preserve foods where modern methods of preservation are not available. Fortification of cereals, which are the foods that are widely fermented together with high protein foods such as soyabeans and milk would improve their protein content and quality.

The fermentation of a finger millet-dairy (skim milk) composite gruel was investigated. This was done to determine what cultures can be used to ferment both the lactose and starch components of the gruels to reduce the pH and produce a safe product. Three starter cultures namely: YC380 and V2, which were developed to ferment dairy products, and JC which was developed to ferment cereal slurries were studied.

The three starter cultures seemed to prefer thermophilic conditions, i.e. an incubation temperature of 45°C. Composite gruels with a pH of 4.5 or below were produced after fermentation at 45°C for 5 and 4 h with starter cultures YC380 and V2, respectively. This is an advantage since rapid acid production at higher temperatures, over a short period of time, reduces the risk of growth of microbial contaminants.

Gruels with a thick consistency were obtained when an incubation temperature of 45°C was used and when the proportion of skim milk was high. Gruels that had low

proportions of skim milk and had been stored at 7°C had high firmness and consistency. This was probably due to retrogradation of the starch in the gruels. Starter culture JC produced an undesirable coagulum. Syneresis was low when the proportion of skim milk was low since with increasing proportions of finger millet gruel the starch probably acted as stabiliser.

The lactose content of the unfermented skim milk and skim milk fermented with starter cultures YC380 and V2 was 5.4%, 4.7% and 4.5% respectively. The lactose content of the unfermented composite gruels and those fermented with starter cultures YC380 and V2 was 2.8%, 1.9% and 2% respectively. Lactose intolerant individuals are the ones who are most likely to benefit from this decrease due to compositing and fermentation. The energy content of the gruels made with finger millet gruel only was 0.9 MJ/kg. The energy content of the unfermented composite gruels and those fermented with starter cultures YC380 and V2 was increased to 1.3 MJ/kg, 1.3 MJ/kg and 1.4 MJ/kg respectively.

The protein content of the gruels that were prepared using finger millet only was 0.4%. The protein content of the unfermented composite gruels and those fermented with starter cultures YC380 and V2 was increased to 2%, 1.9% and 1.8% respectively. The lysine content of the unfermented gruels and those that were fermented with starter cultures YC380 and V2 was 19 mg/g crude protein (CP), 34 mg/g CP and 34 mg/g CP respectively. The lysine content of the unfermented composite gruels and those fermented with starter culture V2 was 54 mg/g CP, 68 mg/g CP and 70 mg/g CP. The increase in the lysine content of the fermented gruels may have been a result of the proteolytic activity and transamination by the bacterial starter cultures.

The importance of nutrients is in terms of their contribution to nutritional requirements. The composite gruels contributed 3% and the gruels with finger millet only contributed 2% to the recommended dietary energy requirements for infants. The contribution to the recommended dietary protein requirements for infants was 3.9% for those gruels that were prepared with finger millet gruel only and 13.9% for the composite gruels. Fermented composite gruels can be produced with skim milk,

finger millet and starter cultures such as YC380 and V2 but not with starter culture JC. Fermentation reduced the pH of the gruels to 4.5 or below. Most pathogenic and spoilage micro-organisms do not grow below this pH.



## UITTREKSEL

### FERMENTASIE VAN 'N DUN PAP BESTAANDE UIT 'N BABALA-SUIWELSAMESTELLING

deur

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Fermentasie word algemeen in Afrika gebruik om voedsel te preserveer waar moderne metodes van preserving nie beskikbaar is nie. Fortifisering van grane, die voedsels wat algemeen gefermenteer word, met proteïenryke voedsels soos sojabone en melk, sal hulle proteïeninhoud en gehalte verbeter.

Die fermentasie van 'n dun pap bestaande uit 'n babala-suiwel (afgeroomde melk) samestelling is bestudeer ten einde geskikte kulture te vind wat gebruik kan word om die laktose sowel as die styselkomponente van die dun pappe te fermenteer en die pH te verlaag ten einde 'n veilige produk te verseker. Drie suurselkulture, naamlik YC380 en V2, wat albei ontwikkel is om suiwelprodukte te fermenteer, en JC, wat ontwikkel is om graanpappe te fermenteer, is bestudeer.

Die drie suurselkulture verkies blykbaar termofiele kondisies, naamlik 'n inkubasietemperatuur van 45°C. Saamgestelde pappe met 'n pH van 4.5 of laer is

verkry na fermentasie by 45°C vir 5 en 4 h met suurselkulture YC380 en V2, onderskeidelik. Dit is 'n voordeel aangesien vinnige suurproduksie by hoë temperature oor 'n kort tydperk die risiko van die groei van mikrobiëse kontaminante verminder.

Pappe met 'n dik konsistensie is verkry wanneer 'n inkubasietemperatuur van 45°C gebruik is en die verhouding van afgeroomde melk hoog was. Pappe wat lae proporsies afgeroomde melk bevat het en wat by 7°C opgeberg is, was baie dik en stewig. Dit was moontlik die gevolg van die retrogradering van die stysel in die pappe. Suurselkultuur JC het 'n onaanvaarbare koagulum geproduseer. Sinerese was laag wanneer die proporsie afgeroomde melk laag was want met toenemende proporsies babalap het die stysel waarskynlik as stabiliseerder opgetree.

Die laktose-inhoud van die ongefermenteerde afgeroomde melk en die afgeroomde melk wat met suurselkulture YC380 en V2 gefermenteer is, was onderskeidelik 5.4%, 4.7% en 4.5%. Die laktose-inhoud van die ongefermenteerde saamgestelde pappe en dié wat gefermenteer is met suurselkulture YC380 en V2, was onderskeidelik 2.8%, 1.9% en 2%. Laktose-onverdraagsame individue sal waarskynlik meeste voordeel trek uit die verlaagde laktose-inhoud as gevolg van samestelling en fermentasie. Die energie-inhoud van die pappe wat met babala alleen berei is, was 0.9 MJ/kg. Die energie-inhoud van die ongefermenteerde saamgestelde pappe en dié wat gefermenteer is met kulture YC380 en V2 is verhoog na 1.3 MJ/kg, 1.3 MJ/kg en 1.4 MJ/kg onderskeidelik.

Die proteïëninhoud van die pappe wat van babala alleen berei is, was 0.4%. Die proteïëninhoud van die ongefermenteerde saamgestelde pappe en dié wat gefermenteer is met kulture YC380 en V2, is verhoog na 2%, 1.9% en 1.8% onderskeidelik. Die lisieninhoud van die ongefermenteerde pappe en dié wat gefermenteer is met kulture YC380 en V2, was onderskeidelik 19 mg/g ruproteïen (RP), 34 mg/g RP en 34 mg/g RP. Die lisieninhoud van die ongefermenteerde saamgestelde pappe en dié wat gefermenteer is met suurselkultuur V2, was 54 mg/g RP, 68 mg/g RP en 70 mg/g RP.

Die toename in die lisieninhoud van die gefermenteerde pappe kan moontlik die gevolg wees van die proteolitiese aktiwiteit en transaminasie deur die bakteriese suurselkulture.

Die belangrikheid van nutriënte lê in hulle bydrae tot voedingsvereistes. Die saamgestelde pappe het 3% bygedra en die pappe met babala alleen het slegs 2% bygedra tot die aanbevole dieetenergiebehoefte van kleuters. Die bydrae tot die aanbevole dieetproteïenvereistes van kleuters was 3.9% in die geval van pappe wat met babala alleen berei is, en 13.9% in die geval van saamgestelde pappe. Gefermenteerde saamgestelde pappe kan geproduseer word met afgeroomde melk, babala en suurselkulture YC380 en V2, maar nie met suurselkultuur JC nie. Fermentasie het die pH van die pappe verlaag na 4.5 of laer. Meeste patogene en bederwende mikro-organismes kan nie groei by hierdie lae pH-waardes nie.



I declare that the thesis submitted for the PhD degree at the University of Pretoria, has not been previously submitted by me for a degree at any other university or institution of higher education.

P. N. gocha  
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**Dedicated to my family (Yona, Yona Menon and Takudzwa Bakili)**

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