CHAPTER 4

RESULTS

4.1 Effect of incubation temperature, type of bacterial starter culture and proportion of finger millet gruel on the lactic acid bacteria count of fermented gruels

The lactic acid bacteria count was significantly affected by the proportion of finger millet and the incubation temperature but not by the bacterial starter culture ($p < 0.05$) (Table 3).

For both starter cultures YC380 and V2 in general, there was a slight increase in the bacterial count, as the temperature of incubation was increased from 37°C to 45°C.

The bacterial count generally decreased as the proportion of finger millet gruel increased (i.e. as the proportion of milk decreased).

Table 3. Effect of proportion of finger millet gruel relative to skim milk, temperature of incubation and type of bacterial starter culture on the lactic acid bacterial count of finger millet-skim milk composite gruels

	Bacterial starter culture			
	YC380		V2	
	Incubation temperature (°C)			
	37	45	37	45
Proportion of finger millet in gruel (%)	Lactic acid bacteria count (log $_{10}$)			
0	8.3	8.5	8.7	8.9
	0	(±0.2)	(±0.1)	(±0.1)
50	7.7	7.6	8.5	8.7
	0	0	(±0.1)	0
100	6.6	6.6	7.3	7.5
	(±0.1)	0	0	0

Figures in brackets are the standard deviation of the mean

4.2 Effect of incubation temperature, type of bacterial starter culture and proportion of finger millet gruel on the physico-chemical characteristics of the fermented gruels

pH

The production of acid was significantly ($p < 0.05$) affected by the temperature of incubation, the proportion of finger millet gruel and the type of bacterial starter culture (Figures 9a-9d).

The lowest pH in the control (no inoculum) was 6.1 (Figure 9a). The gruels that were fermented at 10 and 25°C (lower temperatures) did not achieve a pH of 4.5 or lower, regardless of the proportion of finger millet gruel or starter culture (Figures 9b-9c). A decrease in pH to 4.5 or lower occurred when the gruels were incubated at 30, 37 and 45°C (higher temperatures) (Figures 9b-9c).

Starter culture YC380 produced a pH of 4.5 or lower when the proportions of finger millet gruel in the product were between 0 and 90%, i.e. only when skim milk was present (Figure 9b). The pH was not lowered sufficiently when the proportion of finger millet gruel was 100%. Starter culture V2 effectively lowered the pH of the product to 4.5 or lower at all proportions of finger millet gruel (Figure 9c). Culture JC was more effective in reducing the pH when the proportions of finger millet gruel in the product were between 50 and 100% (Figure 9d). It was not effective when the proportion of finger millet gruel was 0% (skim milk only).

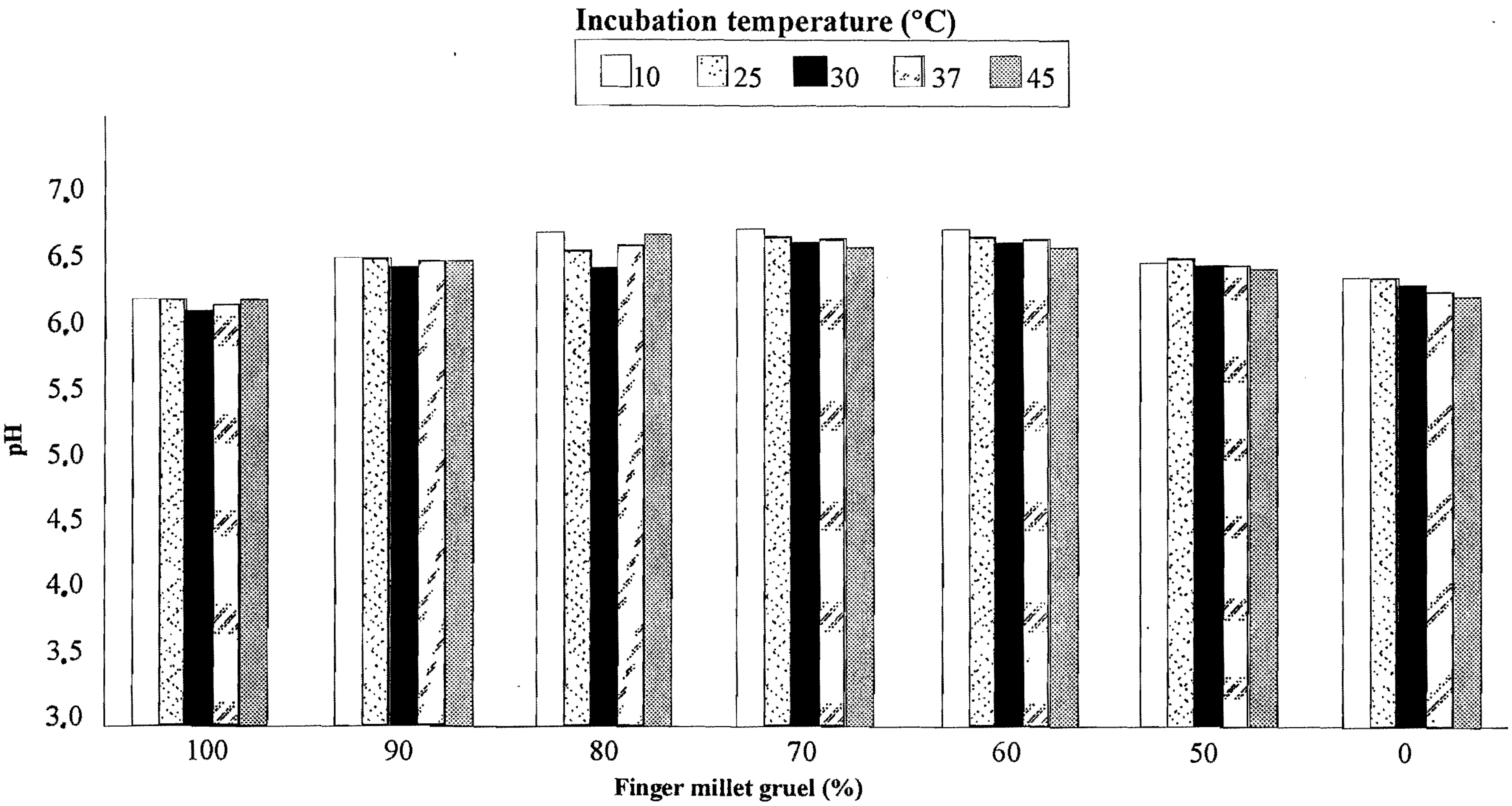

Figure 9a: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the pH of unfermented gruels (Control)

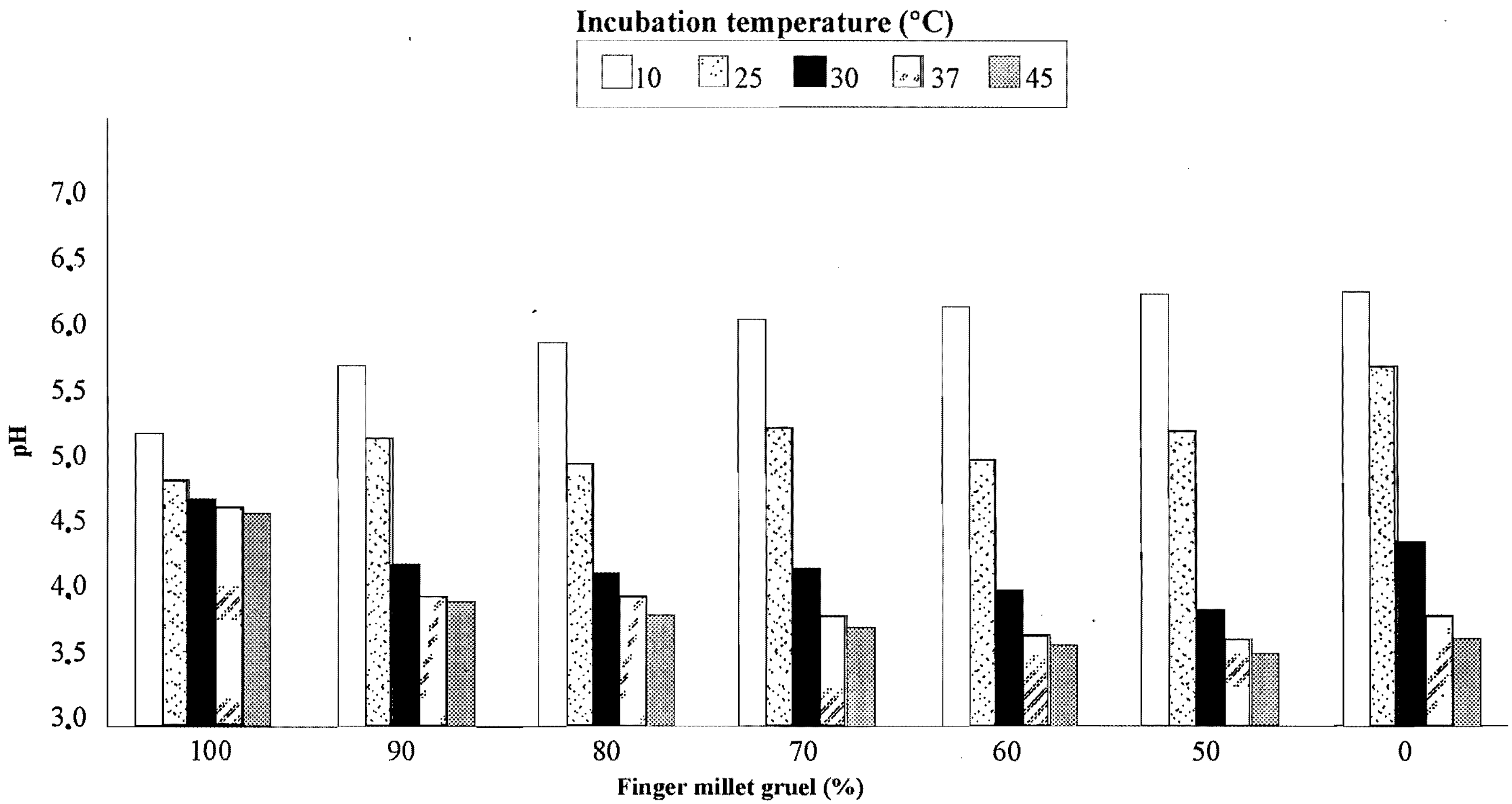

Figure 9b: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture YC380

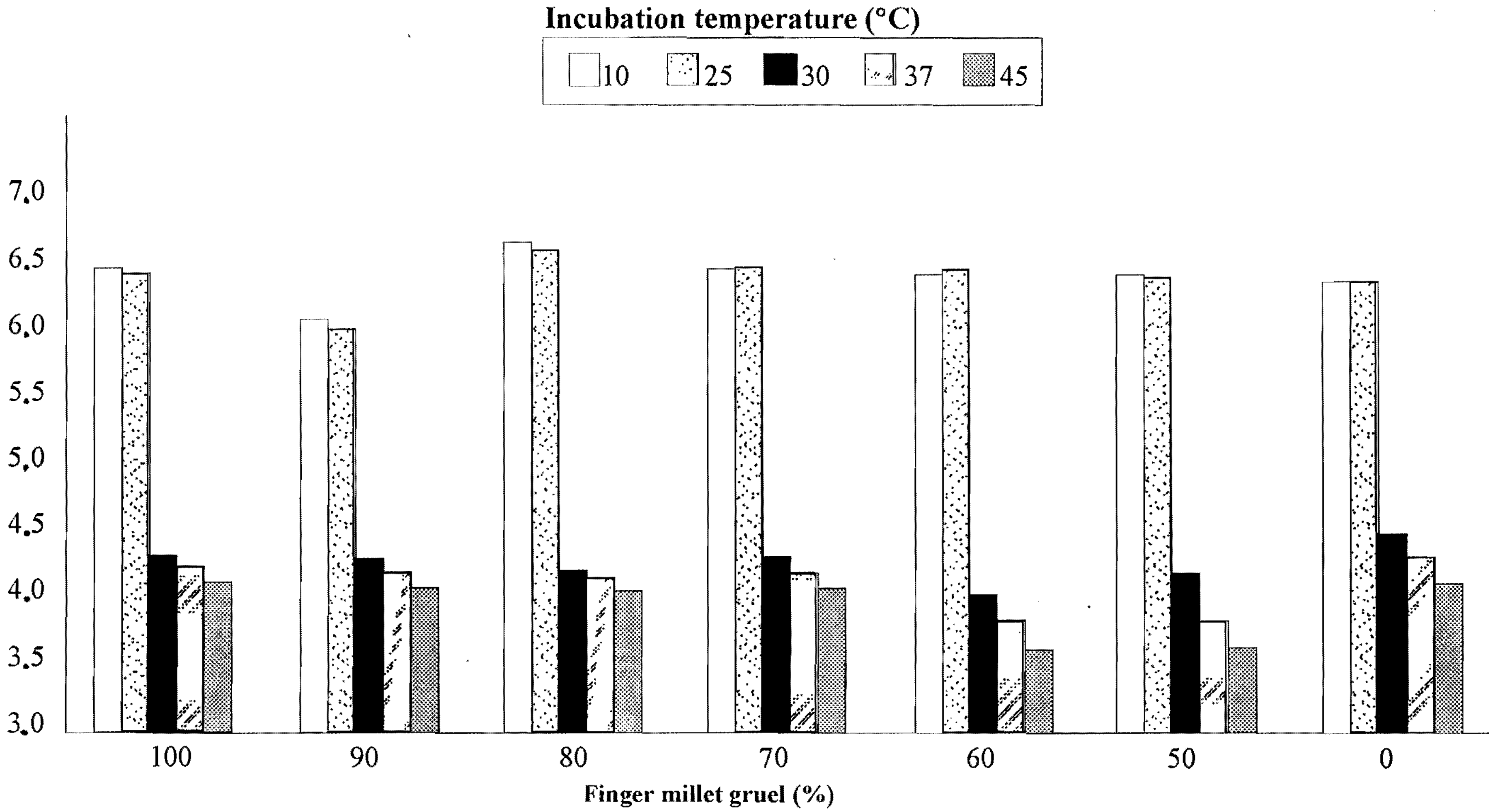

Figure 9c: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture V2

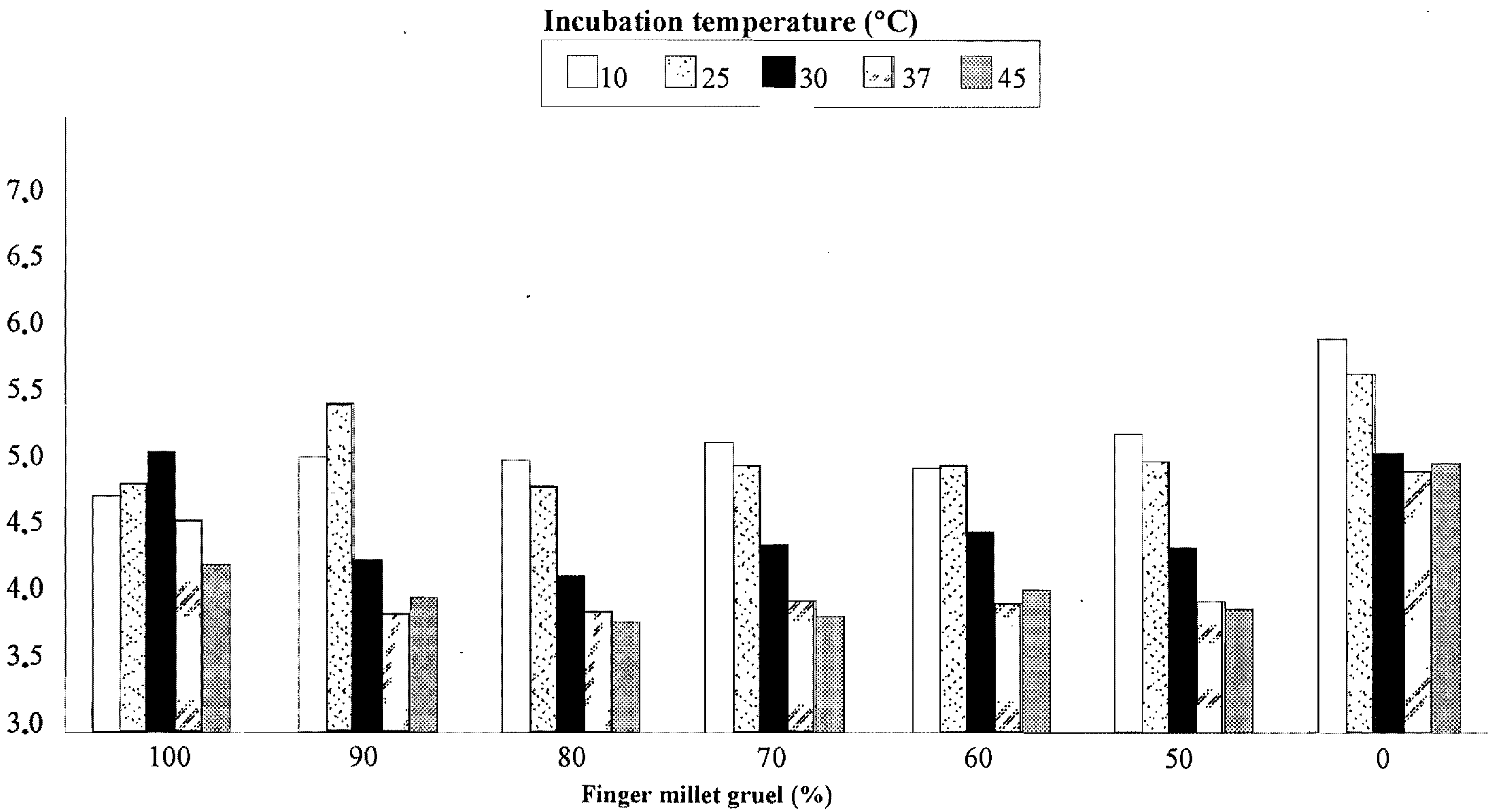

Figure 9d: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture JC

Optimisation of incubation time

The time that the gruels took to attain a pH of 4.5 or lower was significantly ($p < 0.05$) affected by incubation temperature, starter culture and proportion of finger millet gruel.

The effects of incubation temperature and proportion of finger millet gruel were similar to those in the experiment in which the incubation period was fixed. The differences were that firstly, the pH of the fermented gruels after 10 h of incubation was lower compared to gruels that were fermented for 6 h. Secondly, the pH of gruels that were fermented at 37°C was not reduced to 4.5 or lower after 6 h of incubation.

The lowest pH in the control (not inoculated) was 5.86 in the product fermented at 37°C and 5.75 in the product fermented at 45°C (Figures 10a and 10d).

Starter cultures YC380 and V2 did not reduce the pH of finger millet gruels after 6 h when the incubation temperature was 37°C (Figures 10b and 10c).

It took 5 h to reduce the pH of the fermented gruels to 4.5 or lower with starter culture YC 380 and 4 h with starter culture V2, but only in gruels where the proportion of finger millet gruel was between 0 and 90% (Figures 10e and 10f).

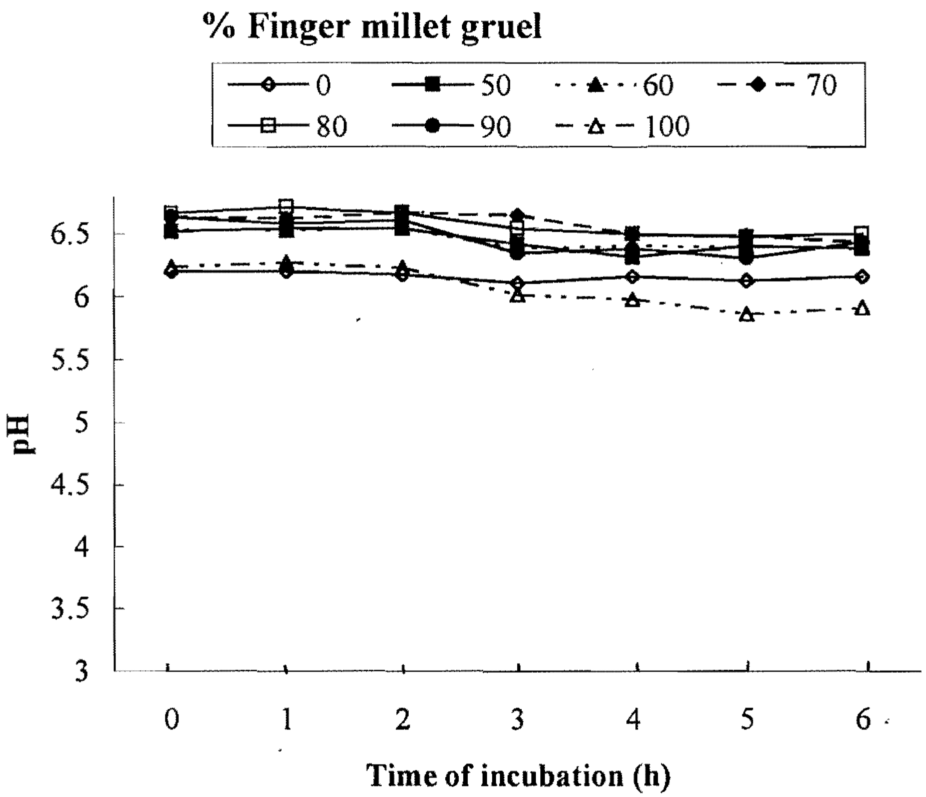

Figure 10a: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of unfermented gruels (control) at 37°C

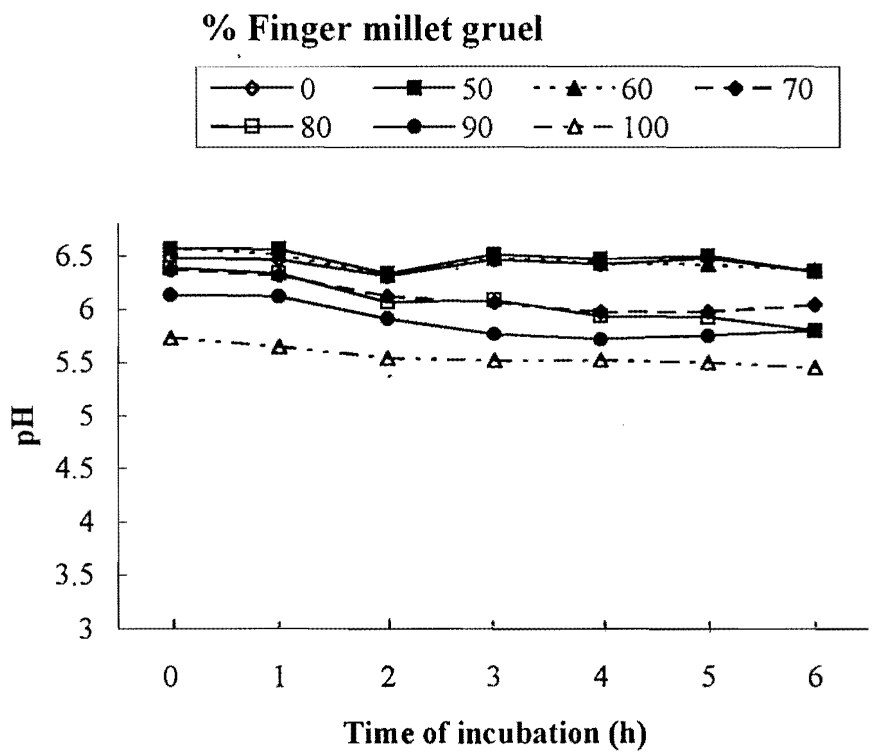

Figure 10b: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture YC380 at 37°C

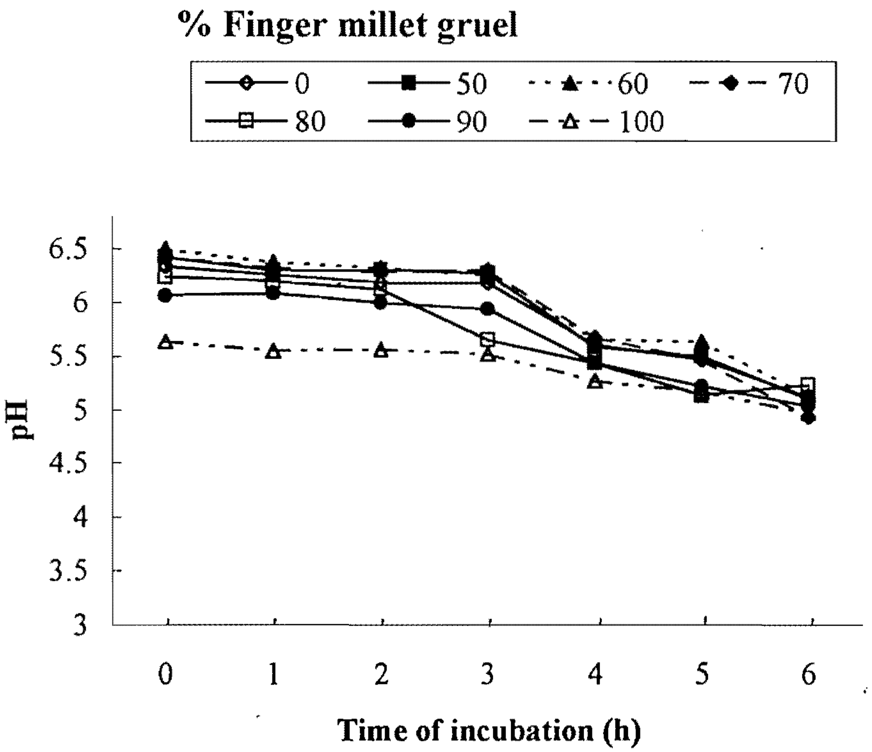

Figure 10c: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture V2 at 37°C

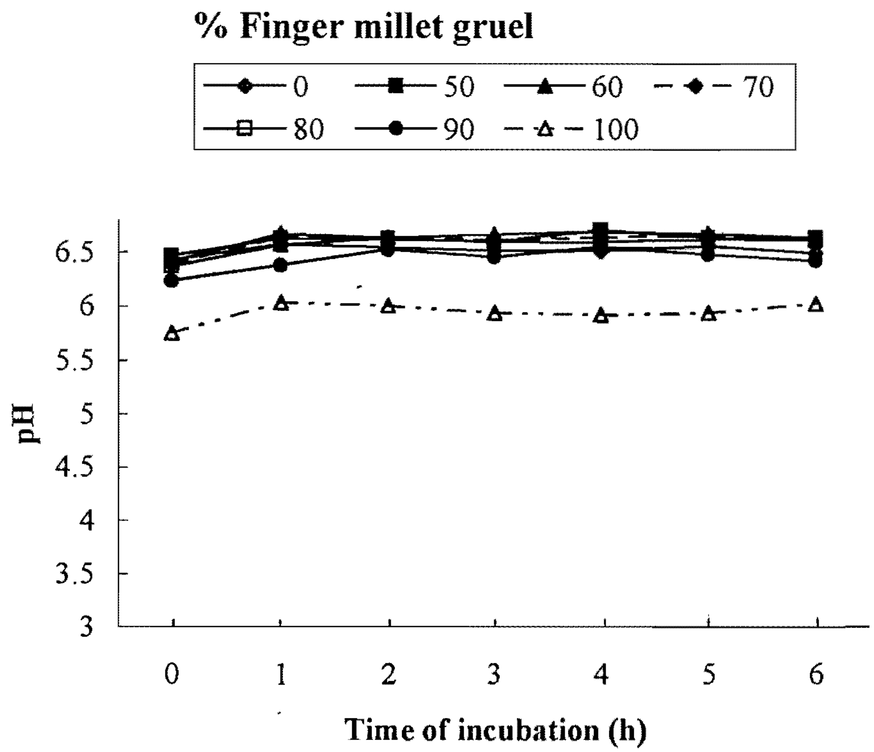

Figure 10d: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of unfermented gruels (control) at 45°C

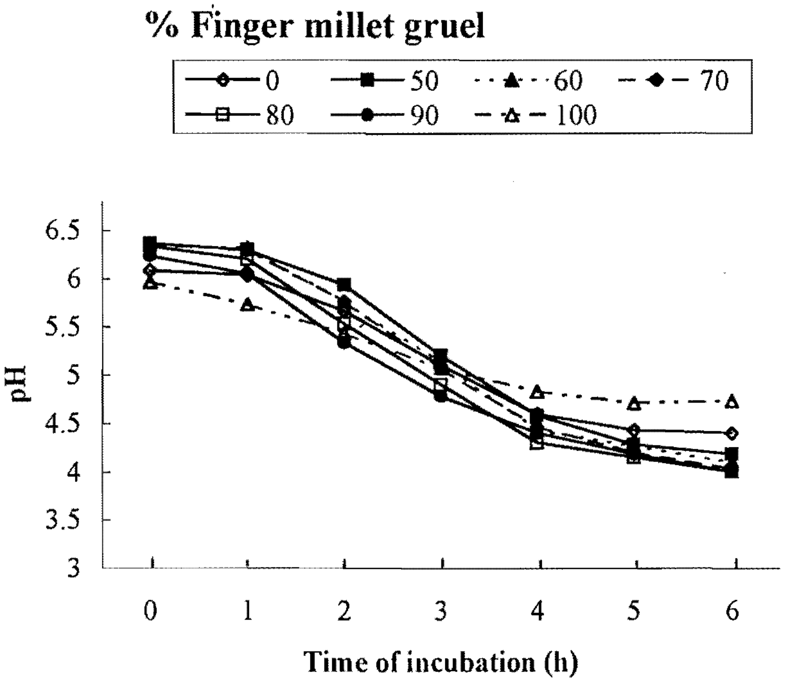

Figure 10e: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture YC380 at 45°C

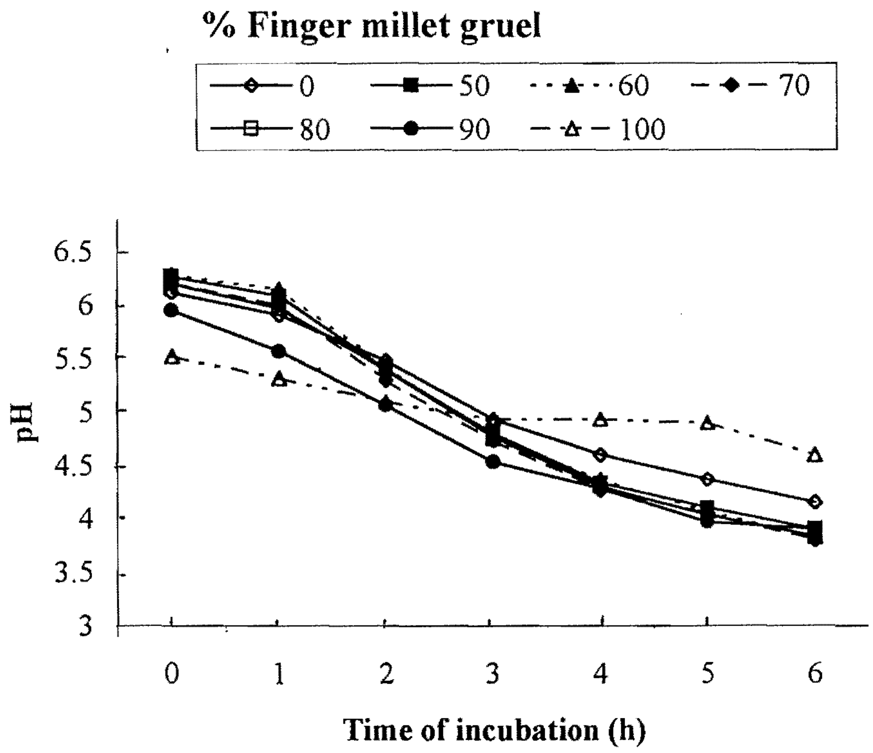

Figure 10f: Effect of the time of incubation and the proportion of finger millet gruel relative to skim milk on the pH of gruels fermented with starter culture V2 at 45°C

Titratable acidity

Titratable acidity was significantly affected by the proportion of finger millet gruel and the type of the bacterial starter culture used ($p < 0.05$). The unfermented milk (control, not inoculated) had an acidity of 0.17% (Figure 11). The unfermented finger millet gruel (control, not inoculated) had a titratable acidity of 0.06%.

Acidity increased as the proportion of finger millet decreased.

Generally, the gruels that were fermented with starter culture V2 developed higher acidity levels compared to those fermented with starter culture YC380. The highest titratable acidity for the fermented finger millet and skim milk composite gruel was 0.6% and it was obtained when starter culture V2 was used.

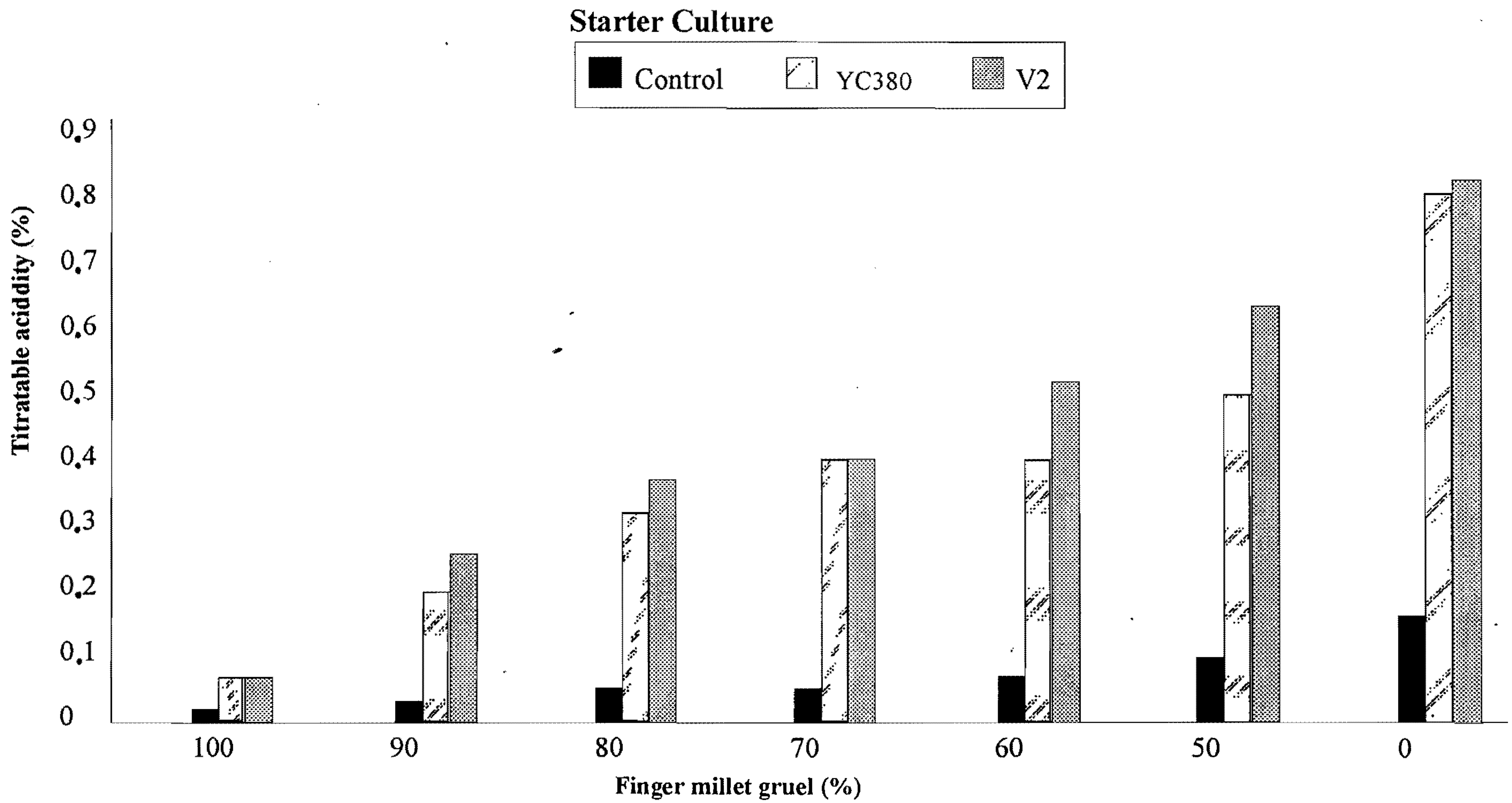

Figure 11: Effect of proportion of finger millet gruel relative to skim milk on the titratable acidity of fermented gruels incubated at 45°C

Syneresis

Syneresis (wheying off) was significantly ($p < 0.05$) influenced by the proportion of finger millet gruel in the composite gruel and the temperature of incubation (Figures 12a and 12b). The type of bacterial culture did not significantly affect syneresis. While there was a significant incubation temperature effect, a trend could not be established between syneresis and increasing/decreasing temperature of incubation. The effect of temperature could not be separated from the effect of proportions of finger millet gruel. Syneresis increased as the proportion of finger millet gruel in the composite decreased. Syneresis was highest when the proportions of finger millet gruel were between 0 and 60%, i.e. when the proportion of skim milk was relatively high.

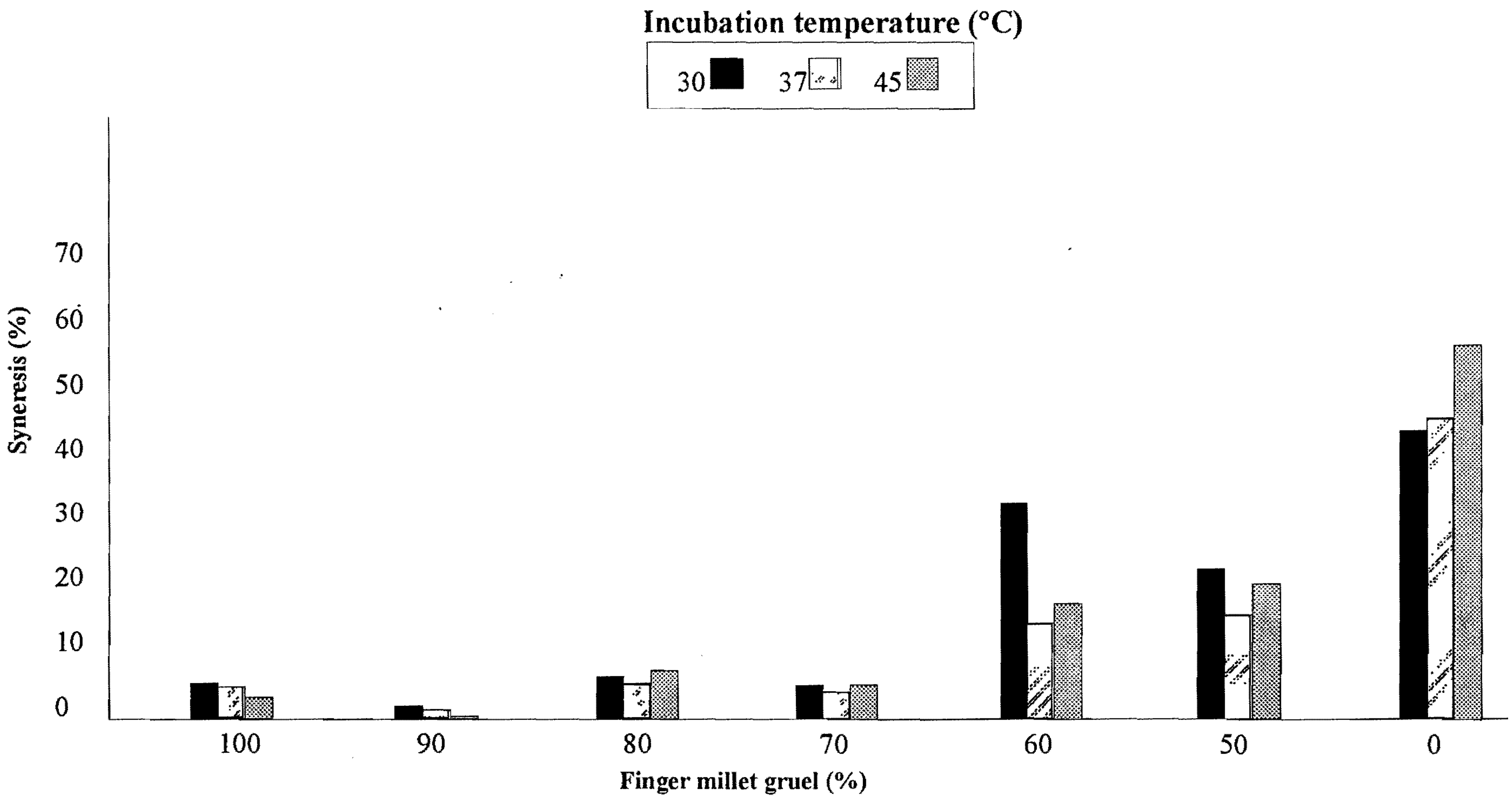

Figure 12a: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on whey syneresis of the gruels fermented with starter culture YC380

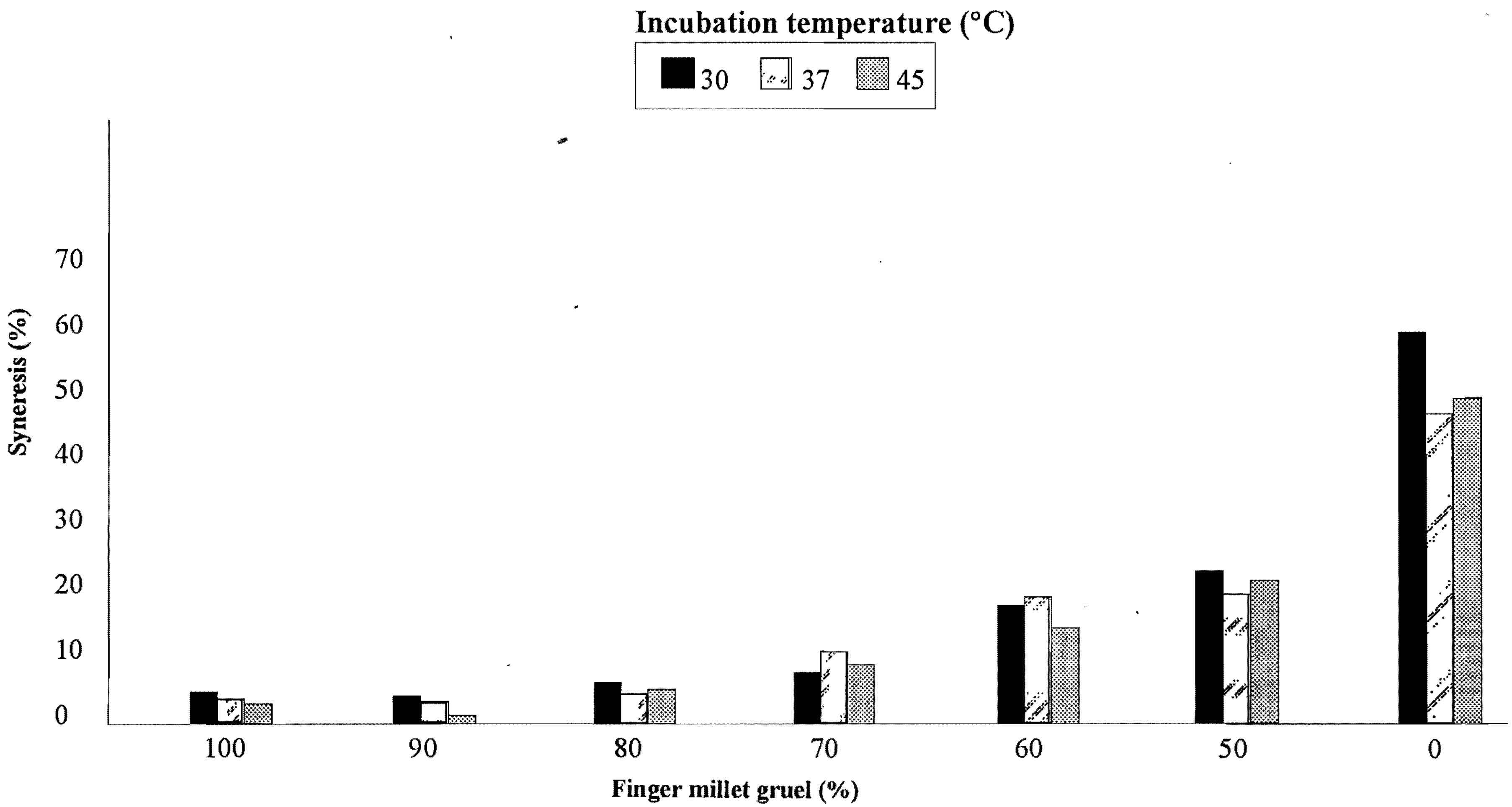

Figure 12b: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on whey syneresis of the gruels fermented with starter culture V2

Consistency

The proportion of finger millet gruel in the composite, the type of bacterial starter culture, the incubation temperature and storage temperature significantly ($p < 0.05$) affected the consistency of the fermented product (Figures 13a-13d).

The highest (thickest) consistencies were obtained when the proportion of finger millet gruel in the gruels was 0% (when there was skim milk only) (Figures 13a-13d). No trend could be established between increasing or decreasing proportions of finger millet gruel and consistency when the storage temperature of gruels was 7°C (Figures 13a and 13c).

Generally the highest consistencies were obtained when an incubation temperature of 45°C, followed by storage at 7°C was used and when the proportions of finger millet gruel were between 0 and 50% (Figure 13a). At 37°C, the highest consistency was obtained when the gruel was fermented using starter culture V2, at a proportion of finger millet of 90% with storage at 7°C (Figure 13c).

The highest consistency was observed when the gruels were stored at 7°C (Figure 13a). Generally, storage at 25°C produced gruels that had lower (thinner) consistency compared to those stored at 7°C (Figures 13a-13d).

Generally, the gruels that were prepared using starter culture YC380 had the higher consistency when the storage temperature was 7°C compared to gruels that were prepared using starter culture V2 at the same storage temperature (Figures 13a and 13c). The thinnest consistencies were observed when the gruels were inoculated with starter culture YC380, stored at 7°C and when the finger millet proportions were between 80 and 100% (Figure 13b).

Visual examination of the fermented products that were obtained when starter cultures YC380 and V2 were used showed differences in consistency and smoothness. The product that was produced with starter culture YC380, had a grainy consistency while the product produced with starter culture V2 had a smooth and slimy consistency.

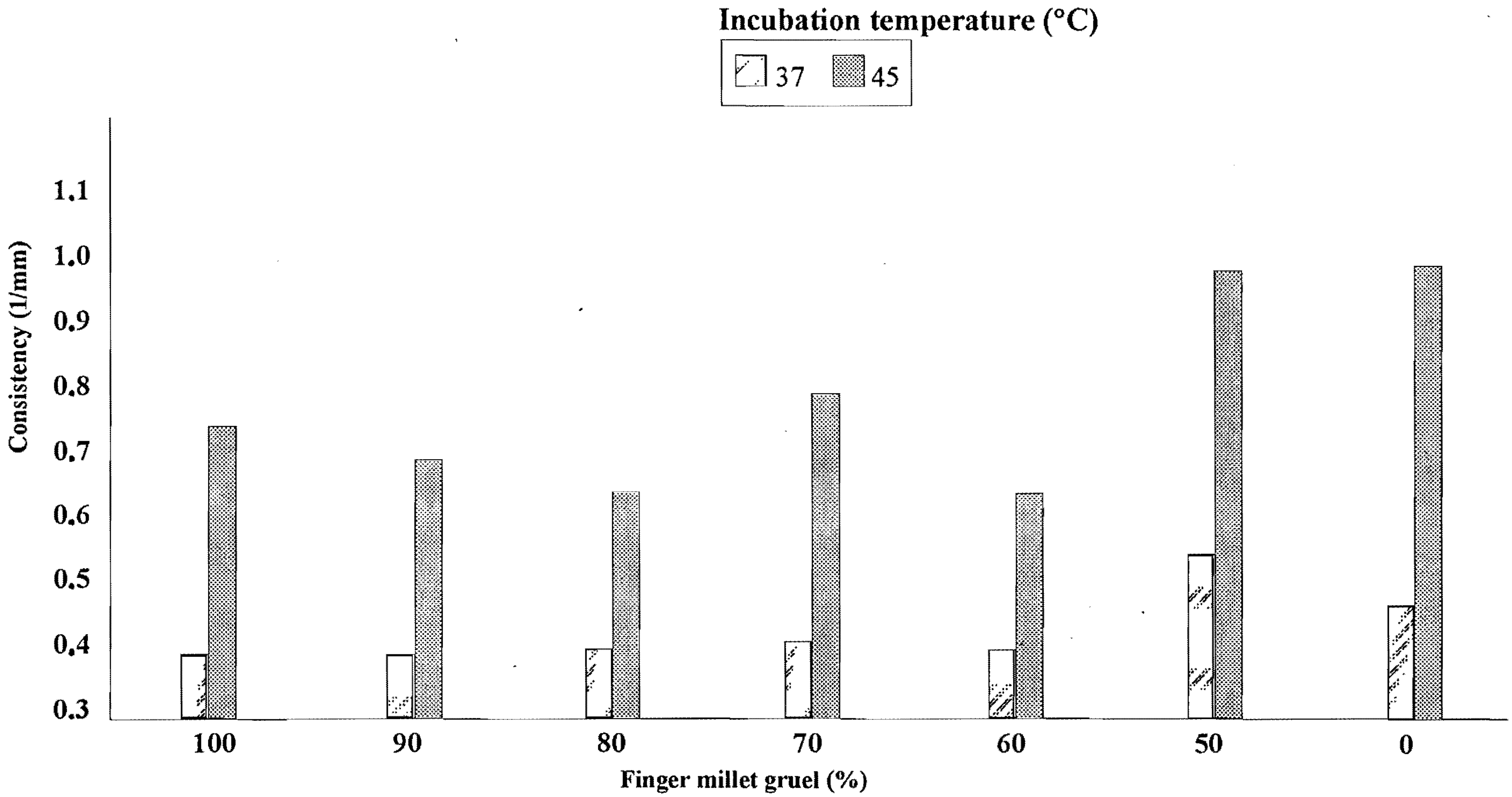

Figure 13a: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the consistency of the gruels fermented with starter culture YC380 and then stored at 7°C

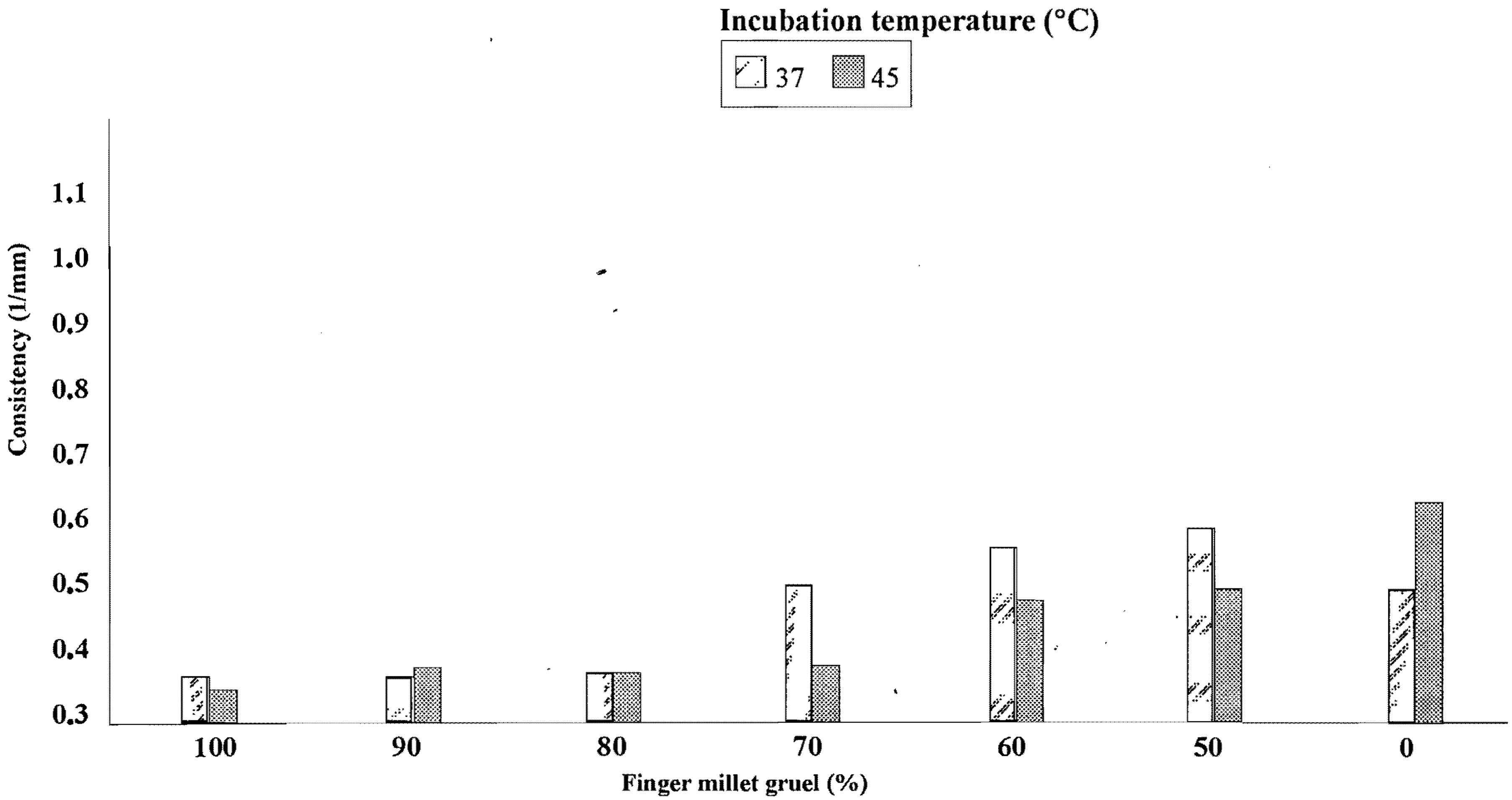

Figure 13b: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the consistency of the gruels fermented with starter culture YC380 and then stored at 25°C

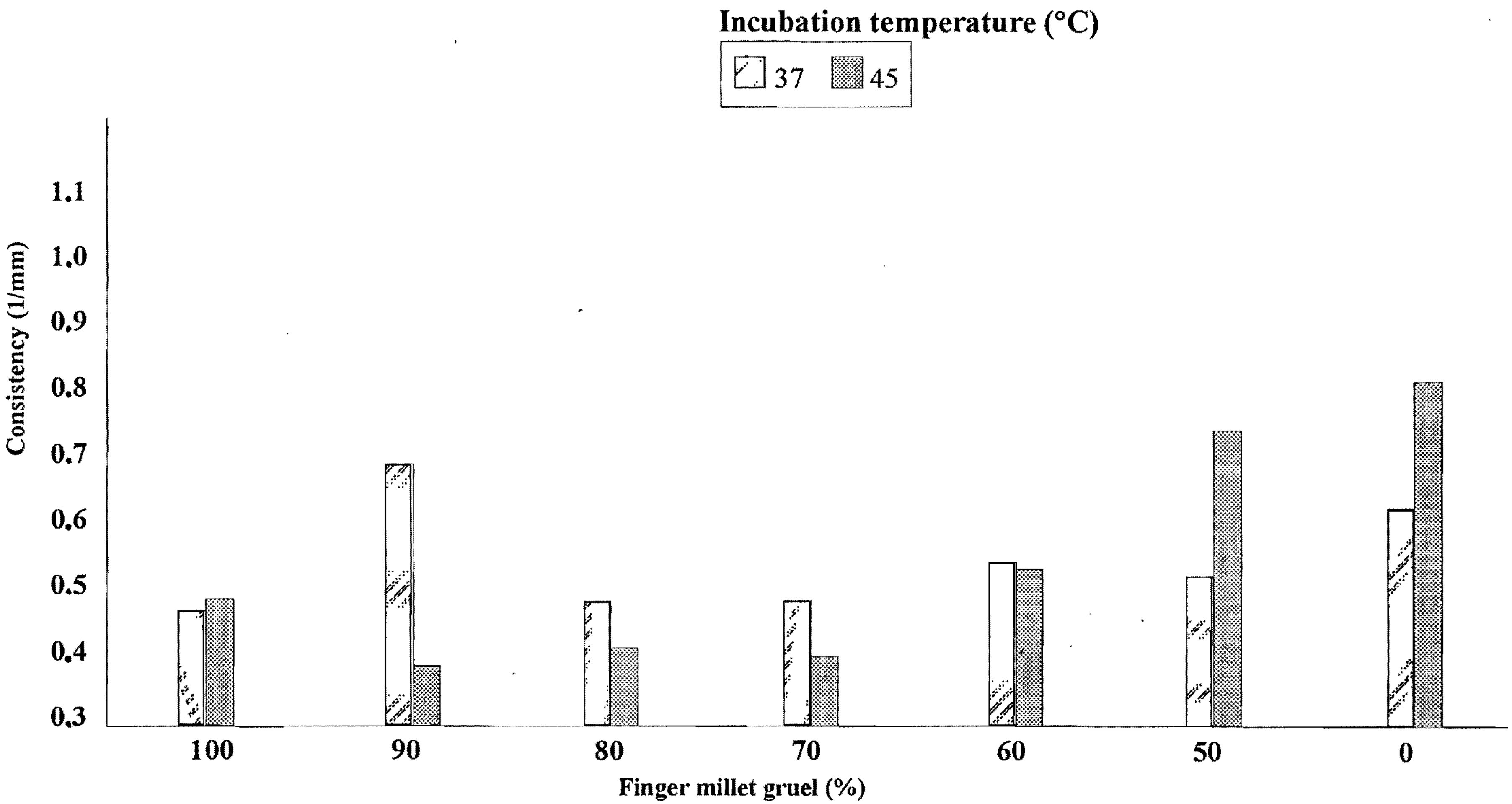

Figure 13c: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the consistency of the gruels fermented with starter culture V2 and then stored at 7°C

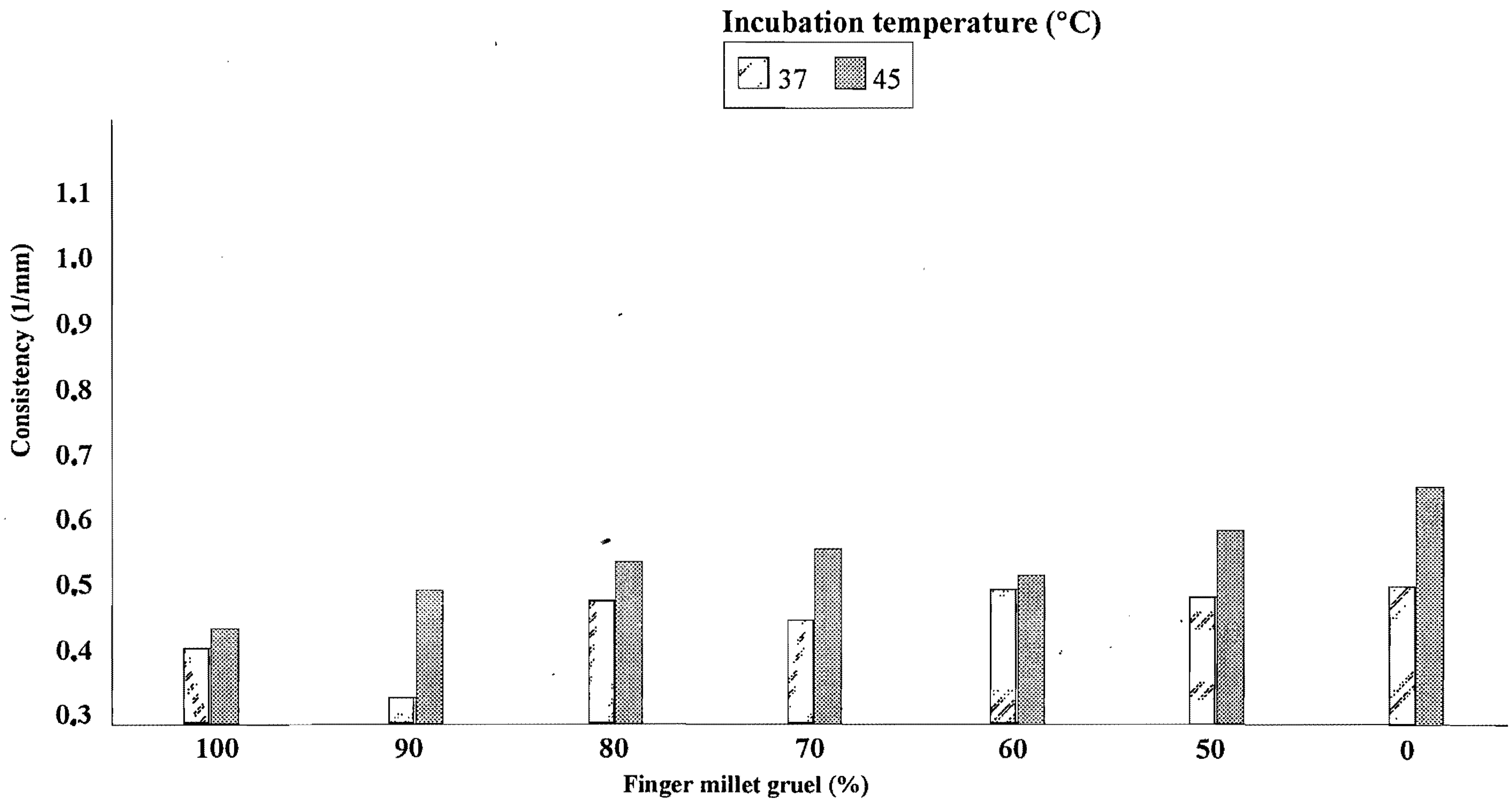

Figure 13d: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the consistency of the gruels fermented with starter culture V2 and then stored at 25°C

Firmness

The proportion of finger millet gruel in the fermented gruel, the type of bacterial starter culture, the incubation temperature and the storage temperature significantly ($p < 0.05$) affected gruel firmness.

Although no trend could be established between increasing or decreasing the proportion of finger millet gruel and firmness of gruel generally, the highest firmness was obtained when the proportion of finger millet gruel was 0% (Figures 14a, 14b and 14d). The exception was a high gruel firmness that was observed when the proportion of finger millet gruel was 90% (Figure 14c).

No relationship could be established between the type of bacterial starter culture and the firmness of the gruel (Figures 14a-14d). The effect of type of bacterial starter culture on firmness appeared to be dependent on the proportion of finger millet in the gruel. Starter culture YC380 produced gruels that had the highest firmness when the proportion of finger millet gruel was 0% (when skim milk only was present) (Figures 14a-14b). The gruels that were produced using starter culture V2 had high firmness values when the proportion of finger millet gruel was 90% (Figure 12c).

No trend could be established between incubation temperature and gruel firmness (Figures 14a - 14d). The effect of incubation temperature on firmness appeared to be related to the proportion of finger millet gruel. Generally, the higher firmness values that were obtained when the incubation temperature was 45°C occurred when the proportion of finger millet gruel was 0% (when skim milk only was present) (Figures 14a-14d). On the other hand, relatively high firmness values were also obtained when gruels were incubated at 37°C and when the proportion of finger millet gruel was 90% (Figure14c) and 100% (Figure 14d).

Generally, a storage temperature of 7°C produced gruels that were firmer than those stored at 25°C (Figure 14a and 14c). Storage at 25°C produced gruels that were relatively firmer when starter culture V2 was used and when the proportions of finger millet gruel were from 80% and 90%.

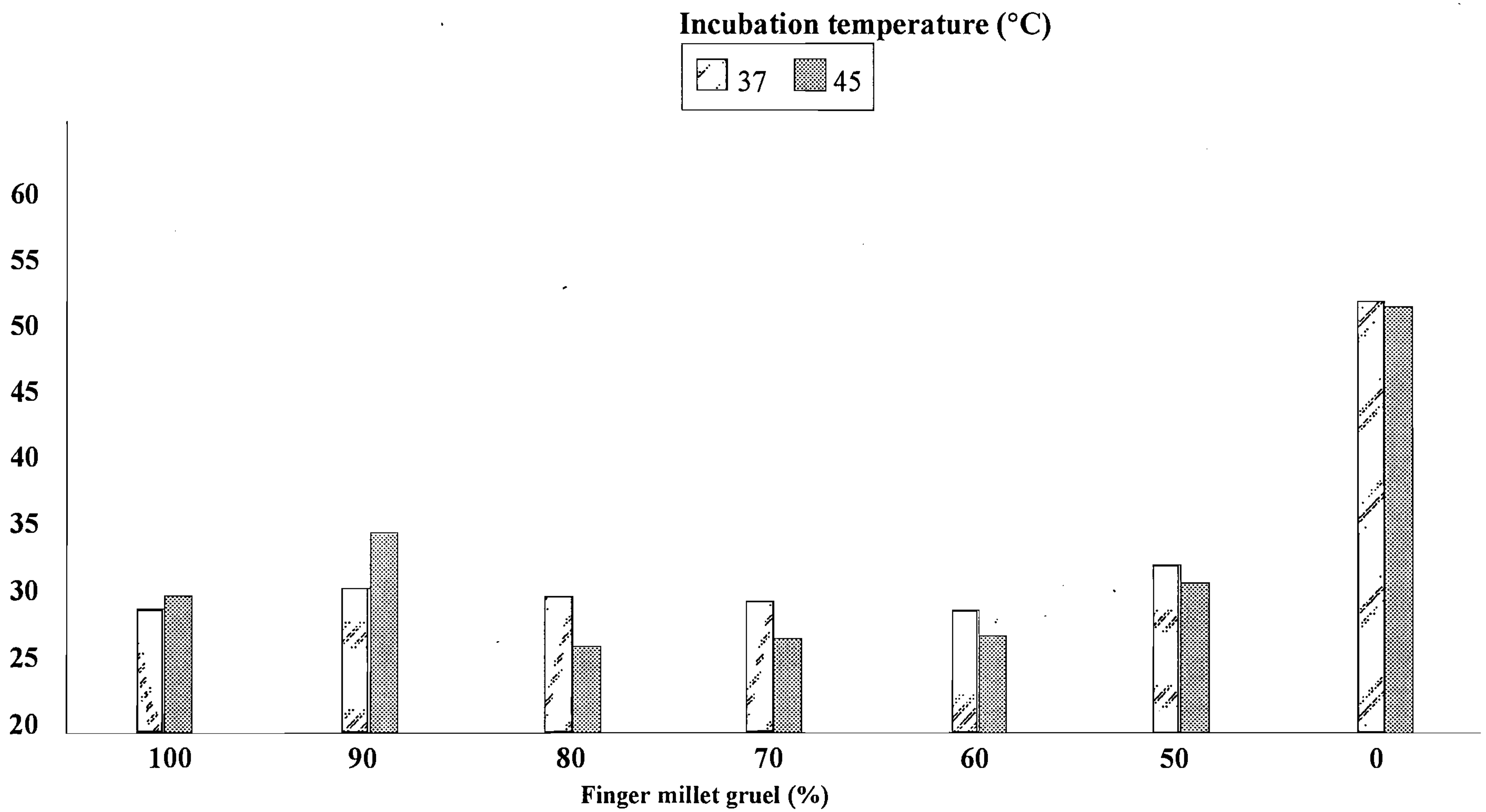

Figure 14a: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the firmness of the gruels fermented with starter culture YC380 and then stored at 7°C

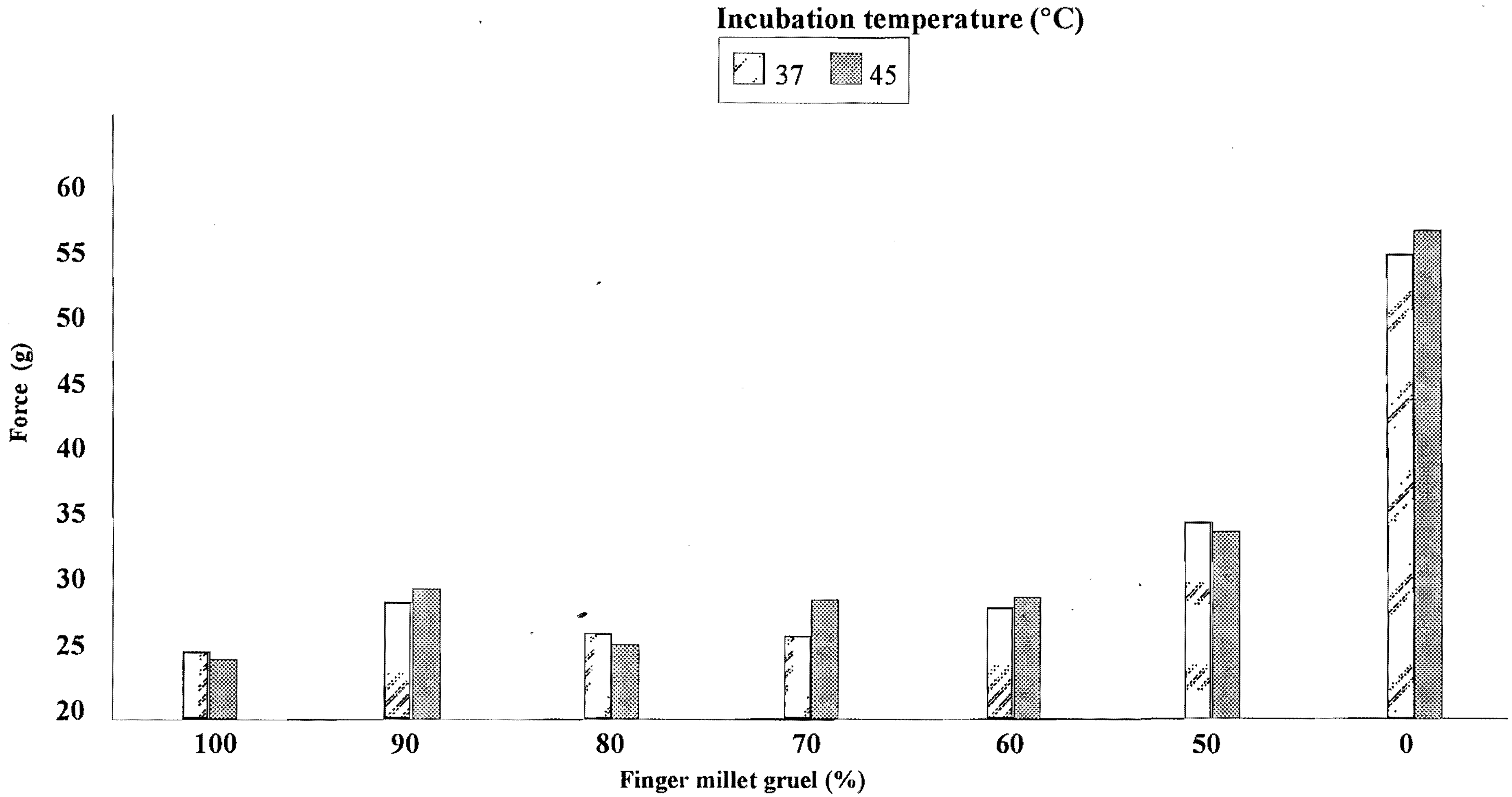

Figure 14b: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the firmness of the gruels fermented with starter culture YC380 and then stored at 25°C

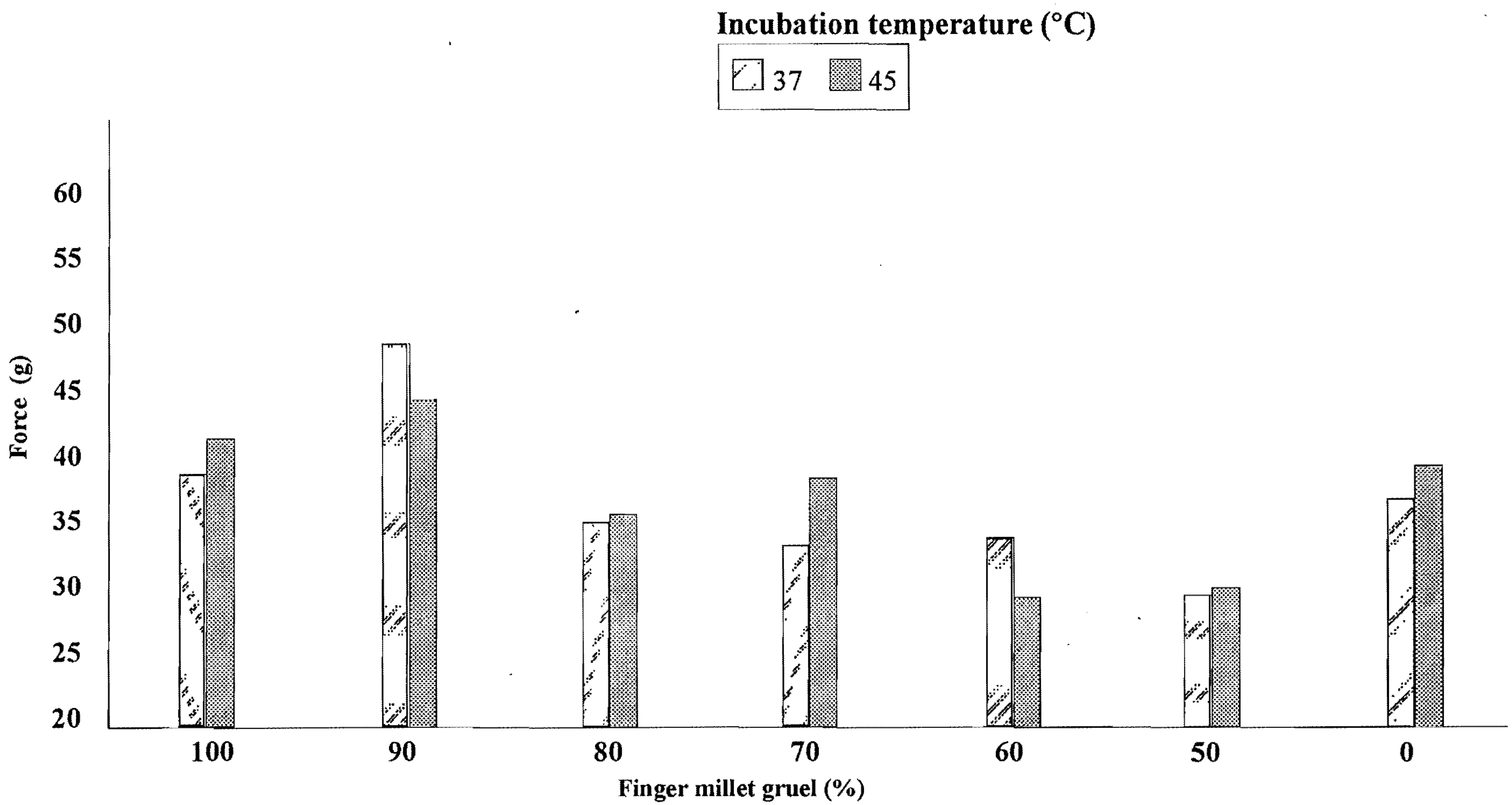

Figure 14c: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the firmness of the gruels fermented with starter culture V2 and then stored at 7°C

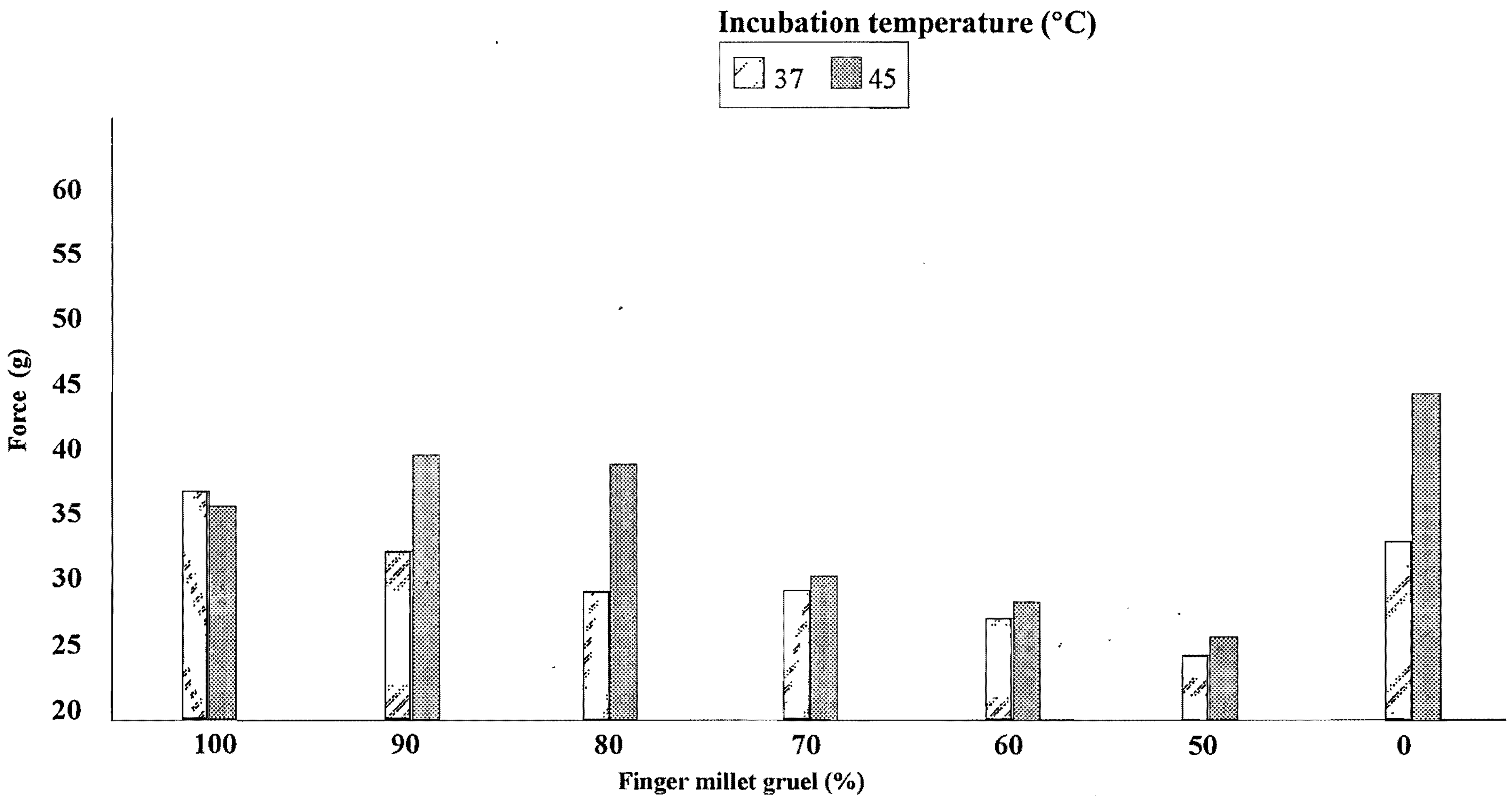

Figure 14d: Effect of the temperature of incubation and the proportion of finger millet gruel relative to skim milk on the firmness of the gruels fermented with starter culture V2 and then stored at 25°C

4.3 Effect of type of bacterial starter culture and proportion of finger millet gruel on the proximate composition of the fermented composite gruels

The proportion of finger millet gruel and the type of bacterial starter culture both significantly affected the proximate composition of the fermented finger millet-dairy composite ($p < 0.05$) (Tables 4 to 6). Generally, the effect of changing the proportion of finger millet gruel was more apparent than the effect of type of bacterial starter culture.

Dry matter

The dry matter content was highest in the unfermented skim milk and lowest in the unfermented finger millet gruel. The unfermented 50% finger millet and skim milk composite gruel had a dry matter content that was between that of finger millet and skim milk (Table 4). The decrease in dry matter with decreasing finger millet proportions was observed with the gruels that were fermented with starter cultures YC380 and V2 (Tables 5 to 6).

The use of bacteria starter cultures YC380 and V2 did not appear to significantly affect the dry matter content of the fermented gruels (Tables 5 and 6 respectively).

Crude protein

The crude protein content was lowest in the unfermented finger millet gruel and highest in the unfermented skim milk. The unfermented 50% finger millet and skim milk composite gruel had a protein content that was almost three times that of the finger millet gruel (Table 4). This increase in crude protein content with decreasing proportions of finger millet was also observed with the gruels that were fermented using starter cultures YC380 and V2 (Tables 5 to 6).

The use of bacteria starter cultures YC380 and V2 did not appear to have a significant effect on the crude protein content of the fermented gruels (Tables 5 to 6 respectively).

Crude fibre

As the proportion of finger millet in the unfermented gruel decreased to 50% in the unfermented gruel, there was no observed change in the crude fibre content (Table 4). This was also observed in the gruels that were fermented with starter cultures YC380 and V2 (Tables 5 to 6 respectively).

The bacteria starter cultures YC380 and V2 did not appear to significantly affect the crude fibre content of the fermented gruels (Tables 5 to 6 respectively).

Crude fat

The unfermented skim milk had a lower crude fat content compared to the unfermented finger millet gruel and the unfermented skim milk and finger millet composite gruel (Table 4). The crude fat content of the gruels that were fermented with starter cultures YC380 and V2 was similar to that of the unfermented gruels (Tables 5 and 6 respectively).

The bacteria starter cultures YC380 and V2 did not appear to influence the crude fat content of the fermented gruels (Tables 5 and 6 respectively).

Lactose

The lactose content of the 50% unfermented finger millet and skim milk composite gruel was lower than that of the skim milk (Table 4). The decrease in lactose with decreasing proportions of finger millet gruel was also observed in the skim milk and the composite gruels that were fermented using starter cultures YC380 and V2 (Tables 5 and 6).

Fermenting the composite gruel and the skim milk with starter cultures YC380 and V2 significantly reduced the lactose content of the fermented gruels (Tables 5 and 6 respectively).

Starch

The starch content of the unfermented finger millet gruel was higher than that of the 50% finger millet and skim milk composite gruel (Table 4). The increase in starch with increasing proportions of finger millet gruel was also observed with the gruels that were fermented with starter cultures YC380 and V2 (Tables 5 and 6).

The use of bacterial starter cultures YC380 and V2 did not appear to significantly affect the starch content of the fermented gruels (Tables 5 and 6 respectively).

Ash

Ash content was highest in the unfermented skim milk and lowest in the unfermented finger millet gruel. The unfermented 50% finger millet and skim milk gruel had an ash content between that of the finger millet and the skim milk (Table 4). The increase in ash content with decreasing proportions of finger millet gruel was also observed when the gruels were fermented with starter cultures YC380 and V2 (Tables 5 and 6).

The ash content of the gruels was not significantly affected by the use of starter cultures YC380 and V2 (Tables 5 and 6 respectively).

Energy

Energy content was highest in the unfermented skim milk and lowest in the unfermented finger millet gruel. The unfermented 50% finger millet and skim milk gruel had an energy content between that of the finger millet and the skim milk (Table 4). The increase in energy content with decreasing proportions of finger millet gruel was also observed when the gruels were fermented with starter cultures YC380 and V2 (Tables 5 and 6).

The energy content of the gruels was not significantly affected by starter cultures YC380 and V2 (Tables 5 and 6 respectively).

Table 4. Effect of the proportion of finger millet gruel relative to skim milk on the proximate composition of a finger millet-dairy composite gruel (Control: not fermented)

	Proportion of finger millet gruel (%)		
Component (g/ 100 g sample)	**100**	**50**	**0**
Moisture	95.1 ±0.2	92.6 ±0.6	89.6 ±0.2
Dry matter	4.9 ±0.2	7.4 ±0.6	10.4 ±0.2
Crude protein	0.4 (8.9) 0 (±0.3)	2.0 (24.8) ±0.1 (±0.8)	3.5 (33.3) ±0.1 (±0.5)
Crude fibre	0.3 (6.1) 0 (±0.3)	0.3 (4.7) 0 (±0.1)	0
Crude fat	0.1 (3.3) 0 (±0.1)	0.2 (2.5) 0 (±0.1)	0.2 (2.0) 0 (±0.1)
Lactose	0	2.8 (34.9) ± 0.3 (±2.8)	5.4 (51.9) ±0.5 (±5.0)
Starch	3.3 (66.2) ±0.2 (±6.2)	1.9 (25.3) 0 (±2.1)	0
Ash	0.2 (3.1) 0 (±0.1)	0.4 (5.4) ±0.1 (±1.1)	0.7 (7.1) ±0.1 (±0.5)
Energy (MJ/kg)	0.9 (17.4) ±0.1 (±1.2)	1.3 (17.4) ±0.1 (±1.1)	1.8 (17.4) ±0.1 (±1.3)

Figures in brackets represent the proximate composition on dry basis
± represents the standard deviation

Table 5. Effect of the proportion of finger millet gruel relative to skim milk on the proximate composition of a finger millet - skim milk composite gruel fermented with starter culture YC380

	Proportion of finger millet gruel (%)		
Component (g/ 100 g sample)	**100**	**50**	**0**
Moisture	94.9 0	92.6 0	89.8 0
Dry Matter	5.1 0	7.4 0	10.2 0
Crude protein	0.4 (7.7) 0 (±0.2)	1.9 (26.2) ±0.1 (0)	3.5 (34.6) ±0.1 (±0.5)
Crude fibre	0.3 (6.4) 0 (0)	0.3 (3.5) 0 (0)	0
Crude fat	0.2 (3.2) 0 (±0.1)	0.2 (2.6) 0 (0)	0.1 (1.2) 0 (0)
Lactose	0	1.9 (29.9) ±0.2 (±3.0)	4.7 (45.9) ±0.2 (±2.1)
Starch	3.4 (66.2) ±0.5 (±4.80)	1.6 (24.6) 0 (±2.5)	0
Ash	0.1 (2.1) 0 (±0.2)	0.6 (7.7) 0 (±0.1)	0.7 (9.0) ±0.2 (±0.2)
Energy (MJ/kg)	0.9 (17.6) ±0.1 (±1.4))	1.3 (17.7) ±0.1 (±1.3)	1.8 (17.3) ±0.2 (±1.6)

Figures in brackets represent the proximate composition on dry basis

± represents the standard deviation of the mean

Table 6. Effect of the proportion of finger millet gruel relative to skim milk on the proximate composition of a finger millet- skim milk composite gruel fermented with starter culture V2

	Proportion of finger millet gruel (%)					
Component (g/ 100 g sample)	**100**		**50**		**0**	
Moisture	94.7		92.2		80.1	
	±0.1		±0.9		0	
Dry matter	5.3		7.8		9.9	
	±0.1		±0.9		0	
Crude protein	0.4	(7.2)	1.8	(23.2)	3.3	(33.8)
	±0.2	(±0.2)	0	(±0.1)	±0.1	(±4.1)
Crude fibre	0.3	(6.5)	0.4	(4.5)	0	
	0	(±0.1)	0	(±0.2)		
Crude fat	0.2	(3.2)	0.2	(2.2)	0.1	(1.2)
	0	(±0.1)	0	(±0.2)	0	(±0.1)
Lactose	0		2.0	(30.6)	4.5	(45.3)
			±0.1	(±1.2)	±0.4	(±3.9)
Starch	3.4	(63.3)	2.2	(27.8)	0	
	±0.3	(±10.7)	±0.2	(±3.3)		
Ash	0.1	(2.3)	0.4	(5.7)	0.9	(8.6)
	0	(±0.3)	0	(±0.1)	0	(0)
Energy (MJ/kg)	0.9	(17.9)	1.4	(17.6)	1.8	(18)
	±0.2	(±1.7)	±0.4	(±1.5)	±0.2	(±1.3)

Figures in brackets represent the proximate composition on wet basis

± represents the standard deviation of the mean

4.4 Contribution of nutrient components to energy in composite gruels

The protein to energy (P-E) ratios of the gruels increased with decreasing proportions of finger millet (Table 7).

Cultures YC380 and V2 did not appear to have much effect on the P-E ratios.

The percentage contribution of fat (% fat kJ) to the total energy of gruels decreased with decrease in the proportion of finger millet gruel.

Bacteria starter cultures YC380 and V2 did not appear to affect the contribution of fat to energy when the gruels had finger millet (i.e. finger millet gruels and 50% finger millet and skim millet composite gruels).

A decrease in the percentage contribution of carbohydrate energy to total energy was observed as the proportion of finger millet in gruels decreased.

Starter cultures YC380 and V2 appeared to reduce the contribution of the carbohydrates to total energy when the gruels contained skim milk (i.e. skim milk only and 50% finger millet and skim milk composite gruels).

Table 7. The contribution of nutrient components to the energy content of fermented finger millet-skim milk composite gruels[1]

	Bacterial starter culture								
	Control (no inoculum)			YC380			V2		
	Proportion of finger millet gruel (%)								
Component	100	50	0	100	50	0	100	50	0
Protein energy (kJ/100 g)	6.8 (151)	34 (422)	59.5 (566)	6.8 (131)	32.3 (445)	59.5 (566)	6.8 (122)	30.6 (394)	56.1 (574)
% Protein energy[2]	7.6	26.2	33.1	7.5	24.8	33.1	7.6	21.9	31.2
Fat energy (kJ/100 g)	7.6 (125)	7.6 (95)	3.8 (46)	7.6 (122)	7.6 (99)	3.8 (46)	7.6 (122)	7.6 (84)	3.8 (46)
% Fat energy	8.4	5.8	4.2	8.4	5.8	4.2	8.4	5.4	2.1
Carbohydrate[3] energy (kJ/ 100 g)	56.1 (1125)	79.9 (1023)	91.8 (882)	57.8 (1125)	59.5 (926)	79.9 (780)	57.8 (1076)	78.2 (992)	76.5 (770)
% Carbohydrate energy	62.3	61.5	51.0	64.2	57.8	44.4	64.2	55.9	42.5

[1] Energy calculated using 17 kJ/g for protein, 17 kJ/g for carbohydrates and 38 kJ/g for fat,
[2] Protein- energy ratio, [3] Lactose and starch, Figures in brackets represent the energy content on dry basis

4.5 Contribution of energy in gruels to daily requirements

The contribution of 100 g of the gruels to daily energy requirements increased with increased proportions of skim milk in the gruels. The contribution of the gruels to energy requirements was highest for infants and lowest for nursing women (Table 8).

Bacteria starter cultures YC380 and V2 did not appear to influence the contribution of the gruels to energy requirements.

Table 8. The contribution (%) of the energy content of fermented finger millet-skim milk composite gruels (per 100 g) to daily energy requirements

	Starter culture									
	Control (no inoculum)			YC380			V2			
	Proportion of finger millet gruel (%)									
	100	50	0	100	50	0	100	50	0	Energy RDA (kJ/ day) [4]
	Contribution per day (%)									
Woman[1]	1.0	1.4	1.9	1.0	1.4	1.9	1.0	1.5	1.9	9360
Pregnant Woman [1]	0.9	1.3	1.8	0.9	1.3	1.8	0.9	1.4	1.8	9990
Nursing woman[1]	0.8	1.1	1.6	0.8	1.1	1.6	0.8	1.2	1.6	11 557
Man[2]	0.8	1.1	1.5	0.8	1.1	1.5	0.8	1.2	1.5	11 630
Infant [3]	2.0	3.0	4.1	2.0	3.0	4.1	2.0	3.2	4.1	4395

[1]A rural 25 year- old woman in a developing country with a weight of 50 kg and a height of 1.6 m, [2] A 25 year old male subsistence farmer with a height of 1.61 m and a weight of 58 kg , [3] A 12 month old male infant [4] (World Health Organisation 1985)

4.6 Contribution of protein in gruels to daily requirements

The contribution of 100 g of the gruels to daily protein requirements increased with increased proportions of skim milk in the gruels. The contribution of the gruels to protein requirements was highest for infants and lowest for nursing women (Table 9).

Starter cultures YC380 and V2 did not appear to influence the contribution of the gruels to protein requirements.

Table 9. The contribution (%) of the protein content of fermented finger millet-skim milk composite gruels (per 100 g) to daily protein requirements

	Starter culture									
	Control (no inoculum)			YC380			V2			
	Proportion of finger millet gruel (%)									
	100	50	0	100	50	0	100	50	0	Protein RDA (g / day) [4]
	Contribution per day (%)									
Woman[1]	1.0	5.0	8.8	1.0	4.8	8.8	1.0	4.5	8.3	39.7
Pregnant woman[1]	0.9	4.7	8.1	0.9	4.4	8.1	0.9	4.2	7.7	43.0
Nursing woman[1]	0.8	4.0	7.1	0.8	3.8	7.1	0.8	3.6	6.7	49.6
Man[2]	0.8	4.2	7.4	0.8	4.0	7.4	0.8	3.8	7.0	47.3
Infant [3]	3.9	19.3	33.8	3.9	18.4	33.8	3.9	17.4	31.9	10.4

[1]25-50 years old and weighing 63 kg, [2]25-50 years old and weighing 75 kg, [3]A 12 month old infant [4] World Health Organisation (1985)

4.7 The effect of the proportion of finger millet gruel and the type of bacterial starter culture on the lysine content of the fermented composite gruels

Lysine content of the fermented composite gruels

The lysine content of the gruels was improved by a decrease in the proportion of finger millet gruel (i.e. the increase in the proportion of skim milk) (Table 10). The increase in lysine content with increasing proportions of skim milk was also observed when the gruels were fermented with starter cultures YC380 and V2.

The use of starter cultures YC380 and V2 significantly improved the lysine content of the fermented finger millet gruel and the 50% finger millet and skim milk composite gruel.

Table 10. Effect of proportion of finger millet gruel and bacterial starter culture on the lysine content (mg/ 100 g of gruel) of finger millet - skim milk composite gruels

	Bacterial Starter culture										
	Control			YC380			V2				
	Proportion of finger millet (%)										
	100	50	0	100	50	0	100	50	0	Milk [1,3]	Finger millet [2,3]
Amino acid											
Lysine	8	108	268	14	128	272	14	126	268		
	(19)	(54)	(77)	(34)	(68)	(78)	(34)	(70)	(77)	(74)	(26-55)

[1] Rosenthal (1991), [2] Serna-Saldivar & Rooney (1995)

Figures in brackets represent lysine content in mg per g crude protein

Contribution of gruels to lysine requirements

The lysine quality of the gruels increased with increased proportions of skim milk in the gruels (Table 11).

Starter cultures YC380 increased the contribution of lysine to requirements based on ideal patterns. Bacterial starter culture V2 increased the contribution of lysine to requirements in the finger millet gruels, 50% finger millet and skim milk gruels but not in skim milk.

The contribution of the protein in the gruel to lysine requirements was highest for adults and lowest for infants.

For adults, the protein of all gruels met the requirements for lysine.

For infants, the protein in the 50% finger millet and skim milk composite gruels met the requirements for lysine when starter cultures YC380 and V2 were used for fermentation.

Table 11. The lysine content of finger millet-skim milk composite gruel protein expressed as a percentage of its quantity in an ideal pattern

	Bacterial Starter Culture									
	Control (no inoculum)			YC380			V2			
	Proportion of finger millet gruel (%)									
	100	50	0	100	50	0	100	50	0	Ideal pattern [1] (mg / g protein)
Infants (12 months)	29	82	116	52	102	118	52	106	117	66
Preschool children (2-5 years)	33	93	133	59	117	134	59	121	133	58
School children (10-12 years)	43	123	175	77	155	177	77	159	174	44
Adults	119	339	478	213	422	486	213	441	484	16

[1]World Health Organisation (1985)