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WATER SUPPLEMENTATION IN EXCLUSIVELY BREASTFED INFANTS AGED 0-6 MONTHS IN HOT AND ARID AREAS: THE CASE OF MERI-MAROUA IN CAMEROON

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DEDICATION

To my mother Mrs EYONG MARTHA MBI and my brother Mr M.E. EYONG,

For leading me into academic pursuits..

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TABLE OF CONTENTS

	PAGE
UCHS ADMINISTRATIVE AND TEACHING STAFF	I
DEDICATION	V
ACKNOWLEDGEMENTS	VI
LIST OF ABBREVIATIONS	VIII
LIST OF TABLES AND FIGURES	IX
SUMMARY	X
RESUME	XII
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	4
3. OBJECTIVES	13
4. METHODOLOGY	15
5. RESULTS	21
6. DISCUSSION	30
7. CONCLUSION	34
8. RECOMMENDATIONS	36
BIBLIOGRAPHY	38
APPENDICES	42

LIST OF ABBREVIATIONS

PRITECH	:	Technologies for Primary Health Care
UCHS	:	University Centre for Health Sciences
Gm	:	Gramme
ml	:	Millilitre
mosm/l	:	Milliosmole per litre
Kcal	:	Kilocalories
u-Bag	:	Self Adhesive Plastic Urine Collector Bag
SD	:	Standard Deviation
WHO	:	World Health Organisation
U.C.	:	Urine Concentration
U. Vol	:	Urine Output Volume
U. SG	:	Urine Specific gravity

LIST OF TABLES AND FIGURES

		Page
Table 1 :	Approximative composition of human milk colostrum and cow milk	6
Table 2 :	Estimated renal solute load from various feedings with dietary intake of sodium potassium and chloride	9
Table 3 :	Summary of studies on water supplementation	12
Table 4 :	Beliefs and practices on water supplementation	23
Table 5 :	Clinical characteristics of infants	24
Table 6 :	Environmental conditions	25
Figure 1:	Age of initiation of water supplementation	25
Figure 2:	Evolution of urine specific gravity in the 2 groups	26
Figure 3:	Evolution of urine concentration in the 2 groups	27
Figure 4:	Urine output volume in the 2 groups	28
Figure 5:	Frequency of enteropathogens in water samples	29

SUMMARY

It is generally agreed that exclusive breastfeeding satisfies caloric and growth needs of infants especially during the first six months of life. Many studies have shown that water supplementation in exclusively breastfed infants aged 0 to 6 months is not necessary. However the latter remains controversial in Sub Sahara Africa and in some parts of the world.

To assess the benefit and the risk of water supplementation of infants exclusively breastfed in hot and arid conditions, we investigated 50 infants of 0 to 6 months of age living in neighbouring rural villages of Maroua (sahelian part of Cameroon).Before this clinical study, 56 mothers and 24 health workers of this locality, were interviewed on the beliefs and practices of water supplementation. To evaluate the risk linked to this practice, 17 drinking water samples were systematically selected from the homes of these infants for bacteriological analysis.

The infants were divided into two groups of 25 subjects each. During 24 hours group A infants were exclusively breastfed while group B (control group) were breastfed and received supplemental water according to their usual habits. Outdoor temperature range was 28-45° C and relative humidity 13-55%.

The 50 subjects were assessed by measuring water intake for group B, and urine output volume and urine specific gravity in both groups at 11: a.m., 2: p.m and 6: p.m in their various homes.
Results show that for a 10 hours period, the mean (SD) water intake in group B was 104 ml (± 46) and the mean (SD) total urine output volume was 44 (± 17) ml in group A and 54 (± 18.6) ml for group B. The mean (SD) urine specific gravities x 1000 for group A were 1005 (± 3.6) in the morning, 1011 (± 9.3) in the afternoon and 1010 (± 7.1) in the evening while those of group B were respectively 1006 (± 5.4), 1007 (± 5.2) and 1009 (± 5.3) and showed no significant difference at any time of the day ($p \geq 0,14$). The evolution of urine concentrations during the study period was similar in the two groups.

All the 17 water samples were contaminated with enteropathogens especially *E. coli* and Klebsiella.

These results clearly show that water supplementation is an early and frequent practice in the study area as 64% of mothers and 71% of medical personnel interviewed encouraged water supplementation at birth and 90% of our infants were receiving water supplements before recruitment for the study.

In conclusion the results show that there is no significant difference between the two groups in urine output and specific gravity and confirms conclusions reached by earlier researchers that water supplementation offers no benefit in exclusively breastfed infants aged 0 to 6 months. Moreover, given the high level of water contamination, water supplementation in such areas constitutes a dangerous source of enteropathogens which are potentially responsible for infantile diarrhoea.

Considering the results we recommend the following:

1. Health education of health personnel on exclusive breastfeeding of infants in the first 4 to 6 months of life and the possible risk associated with water supplementation in this age group.

2. Health education of the population on the advantages of exclusive breastfeeding and the non beneficial practice of water supplementation in exclusively breastfed infants in the first 4 to 6 months of life; and the risk of infection associated with water supplementation in the said age group.

RESUME

Il est généralement admis que l'allaitement maternel exclusif couvre les besoins énergétiques et protidiques du nourrisson pendant les premiers 6 mois de la vie. Cependant, bien que de nombreuses études aient montré l'inutilité de la supplémentation en eau des enfants allaités exclusivement au sein, le sujet reste toujours controversés en Afrique Sub-Saharienne et ailleurs dans le monde.

Pour étudier le bénéfice et le risque de la supplémentation en eau des enfants allaités exclusivement au sein, l'état d'hydratation de 50 nourrissons âgés de 0 à 6 mois et vivant dans des villages voisins de la ville de Maroua (Région sahélienne du Cameroun) a été investigué de manière contrôlée. Auparavant, un échantillon de 56 mères et 24 agents de santé ont été interrogés sur les coutumes et les pratiques de la supplémentation en eau chez les nourrissons exclusivement nourris au sein. Pour évaluer le risque lié à cette pratique, 17 échantillons d'eau administrée aux nourrissons ont été systématiquement sélectionnés pour analyse bactériologique.

Ces sujets ont été répartis en 2 groupes de 25 enfants chacun: le groupe A constitué d'enfants ne recevant que du lait maternel et le groupe B d'enfants recevant en plus de leur allaitement maternel des suppléments d'eau selon les coutumes traditionnelles de ces localités.

Dans ces localités les températures extérieures variaient entre 28-45°C et l'humidité ambiante quant à elle passait de 13% à 55% au cours de la journée.

Chez chacun des 50 nourrissons l'on a mesuré au cours des périodes de la journée 11h, 14h et 18h les données suivantes: le volume d'eau ingéré pour le groupe B, le volume urinaire émis pendant 10 heures et la densité spécifique de l'urine collectée au cours de ces trois périodes.

Les résultats montrent:

1. Que la supplémentation en eau est fréquemment pratiquée tôt dans la région d'étude puisque 64% des mères et 71% des personnels médicaux interrogés ont encouragé la supplémentation en eau dès la naissance et 90% de nos nourrissons recevaient un supplément en eau avant le recrutement pour l'étude.

2. Que le volume d'eau moyen (SD) ingéré pour le groupe B pendant les 10 heures est 104 ml (± 46) et le volume urinaire moyen (SD) émis pendant les 10 heures est comparable dans les 2 groupes soit 44 ml (± 17) dans le groupe A et 54 ml (± 18,6) dans le groupe B.

3. La densité spécifique moyenne (SD) des urines x 1000 du matin, de l'après-midi et de la fin de la journée sont respectivement équivalentes: 1005 (± 3,6), 1011 (± 9,3), 1010 (± 7,1).pour le groupe A et 1006 (± 5,4), 1007 (± 5.2), 1009 (± 5,3) pour le groupe B. Cette différence n'est pas statistiquement significative ($p \geq 0,14$).

4. L'évolution des concentrations urinaires est similaire dans les 2 groupes A et B.

5. L'examen bactériologique des 17 échantillons d'eau sélectionnés systématiquement a révélé que tous étaient contaminés par des bactéries entéropathogènes, principalement les souches de *E. coli*, et Klebsiella..

En conclusion, les résultats de ce travail confirment ceux des précédentes études effectuées dans d'autres régions arides et chaudes du globe suggérant que la supplémentation en eau des nourrissons âgés de 0 à 6 mois, exclusivement allaités au sein maternel ne confère aucun avantage du point de vue de l'équilibre hydrique.

Nos résultats suggèrent en outre que la contamination bactérienne élevée des sources d'eau constitue un risque considérable d'infections entérales pour les nourrissons dans les localités étudiées.

Au vu de ces résultats nous recommandons:

1. Un renforcement de l'éducation pour la santé du personnel sanitaire sur la promotion de l'allaitement maternel exclusif dans les premiers 4 à 6 mois de la vie et en particulier le risque associé à la supplémentation en eau dans cette tranche d'âge.

2. L'éducation pour la santé des populations en matière d'allaitement maternel exclusif et le risque associé avec la supplémentation en eau des nourrissons dans les premiers 4 à 6 mois de la vie.

CHAPTER 1

INTRODUCTION

1.1. PROBLEM IDENTIFICATION AND DEFINITION

The act of breastfeeding started from time immemorial. It could be considered as the best thing a loving mother could offer her newborn baby. Today the act is increasingly declining to the advantage of supplemental fluids. The incidence of fluid (water, cowmilk, tonics, concoctions etc) supplementation is higher in developed countries than in their underdeveloped counterparts (Maquort et al, 1990). However it is difficult to find a good percentage of exclusively breastfed infants in these underdeveloped countries.

It is generally agreed that exclusive breastfeeding satisfies caloric and growth needs of infants especially during the first six months of life but doubt is still raised on whether breastmilk alone can meet up with water needs to maintain homeostasis and a safe hydration margin in hot and arid areas. From interviews in present study and former ones (Sachdev et al, 1991), it is for the above sceptism that some parents, paramedical and medical staff encourage water supplementation of breastfed infants. However, this is on the basis of caution rather than knowledge on the subject as scanty literature that exist is still to gain grounds.

The act of supplementation may be harmless where contamination of water and utensils used in serving it is not likely, but becomes a major concern where contamination is likely as it is the case in the underdeveloped countries where a good percentage of the population lacks potable water and basic hygiene rules not usually respected. This exposes the baby to infections such as gastroenteritis. Moreover supplementation may indirectly reduce milk output and eventually may lead to early termination of breastfeeding, (Sachdev et al, 1991), a health hazard on its own

Theoretical calculations on renal solute load of human milk and water requirements of infants in hot and dry climate suggest that exclusively breastfed babies can maintain hydration in health (Ziegler and Fomon, 1971; Almroth S.G., 1978). A few clinical studies existing conclude that water supplementation is not necessary. The works were carried out in different areas with vast climatic conditions (temperature and relative humidity).

Apart from Sachdev and collaborators, no other researchers carried out a comparative study with a control group and only a few authors had a satisfactory sample size. There was need to carry out a study on this subject in a hot and dry Sub-Sahara region.

The aim of this study was to carry out a comparative field study between infants exclusively breastfed and those breastfed and receiving supplemental water in order to evaluate the benefit and risk of water supplementation in exclusively breastfed infants in a very hot and arid Sub-Sahara area such as Maroua in Cameroon.

1.2. RATIONALE

To ascertain conclusions reached by earlier researchers that water supplementation in exclusively breastfed infants in hot and arid areas is not necessary, this study was conducted in a hot and arid area in Cameroon.

In case the results indicate that water supplementation in these infants in the said area is not necessary, a countrywide public health campaign against water supplementation will help reduce the level of infection incurred by these infants. This will be cost effective in the long run.

1.3. HYPOTHESIS

The hydration status of infants being breastfed and receiving supplemental water is no better than that of infants exclusively breastfed.

CHAPTER 2

REVIEW OF LITERATURE

Our literature review will be based on the following sub chapters:

2.1. WATER NEEDS OF INFANTS AND HUMAN MILK COMPOSITION
2.2. THE KIDNEY AND URINARY CONCENTRATION CAPACITY OF INFANTS
2.3. RENAL SOLUTE LOAD OF HUMAN MILK
2.4. EARLIER WORKS ON WATER SUPPLEMENTATION.

2.1.1. Water needs of infants

Water is second only to oxygen as an essential factor for existence. Lack of it results in death in a matter of days (Lewis Barness, 1979). An infant requires 80-155 ml of water per kilogram of body weight per day. Water balance depends on variables, such as fluid intake, protein and mineral content of the diet, solute load presented for renal excretion, metabolism, respiratory rate and body temperature. The natural food of infants, breastmilk, is high in water content (Lewis Barness, 1979).

2.1.2. Human milk composition

Human milk provides about 700 kcal per litre. Water constitutes 88% of human milk. It is of superior quality compared to other kinds of milk (Lewis, Barness, 1979). See table I

2.1.3. Non nutritive qualities of human milk

Human milk contains the following:

1. Anti-infection
eg: Macrophages, polymorphonuclear cells, T and B lymphocytes, interferon, lysozyme, lactobacillus bifidus factor, immunoglobulins A, IgM, IgG, IgD, Complement C1-C9, heamaglutinin Inhibitors etc.

2. Enzymes
eg: lipase, lactoperoxidase, ribonuclease, etc.

3. Hormones
Thyroid stimulating hormone, thyroid releasing hormone, prolactin, thyroxine (T3, T4) and growth hormone releasing hormone, etc.
From MAY J.T. (1988), MORRISS F.H. (1986).

Table 1: Approximate composition of human milk, colostrum and cow milk

Constituent GM/100 gm	Human milk	Human colustrum	Cows milk
- WATER	88	87	88
- PROTEIN	1.1	2.7	3.3
casein	0.4	1.2	2.7
lactalbumin	0.4		0.4
lactoglobulin	0.2	1.5	0.2
- FAT	3.8	2.9	3.8
- LACTOSE	7.0	5.3	0.8
- ASH	0.2	0.5	0.8
Calcium mg/100gm	34	30	117
Phosphorus Mg/100 gm	15	15	92
Sodium Meq/l	7	48	22
Potassium Meq/l	13	74	35
Chloride Meq/l	11	80	29
Magnesium mg/100 gm	4	4	12
Sulfur Mg/100 gm	14	22	30
Chromium ug/l	-	-	10
Manganese -"-	10	trace	30
Cooper -"-	400	600	300
Zinc -"-	4	6	4
Iodine -"-	30	120	47
Selenium -"-	30	-	30
Iron -"-	0.5	0.1	0.5
- AMINO ACIDS (Mg/100 ml)			
Histidine	22		95
Leucine	68		228
Isoleucine	100		350
Lysine	73		88
Methionine	25		172
Phenylalanine	48		164
Threonine	50		49
Tryptophan	18		95
Valine	70		228
Arginine	45		350
Alanine	35		277
Aspartic acid	16		88
Cystine	22		172
Glutamic acid	230		164
Glycine	0		49
Proline	80		245
Serine	69		129
Tyrosine	61		75
- VITAMINS (liter)			
Vitamin A (iu)	1898		1025
Thiamine (ug)	160		440
Rboflarine (-"-	360		1750
Niacin (-"-)	1470		940
Pyridoxine (-"-)	100		640
Panthotenate (mg)	2		3
Folacin (ug)	52		55
B12 (-")	0.3		4
Vitamin C mg (mg)	43		11
Vitamin D (iu)	22		14
Vitamin E (mg)	2		0.4
Vitamin K (ug)	15		60

From Nelsons textbook of pediatrics, 1979, page 198 SAUDERS

2.2. THE KIDNEY

2.2.1. Physiological review

The kidney performs two major functions: firstly, it excretes most of the end products of bodily metabolism and secondly it controls the concentration of most of the constituents of body fluids and also facilitates water conservation. Its endocrine function will not be mentioned here. The kidney consumes about 10% of body oxygen and 25% of cardiac out put (Guyton, 1981).

2.2.2. Urinary concentration capacity of infants

Each kidney contains about 1.2 million nephrons, each nephron capable of forming urine independently. The basic function of the nephron is to clear or purify the blood plasma of unwanted substances as it passes through the kidney. The substances include particularly end products of metabolism such as urea, creatinine, uric acid, urates and plasma subtances such as sodium, potassium, chloride and hydrogen ions are cleared of excesses. The mechanism by which the kidney accomplishes this is by filtration and reabsorption, unwanted substances are not reabsorbed while the wanted ones are absorbed such as water and many electrolytes as the filtrate passes through the tubules. A second mechanism by which the nephron clears the plasma is by secretion of unwanted substances through the tubular epithelial cells into the tubular fluid. At the proximal convulated tubule most of the water, 70% sodium, glucose and aminoacids are reabsorbed. At the loop of Henle no water is reabsorped, 20-25% sodium and chloride are reabsorbed. At the distal convulated tubule, 10% or less of sodium is reabsorbed under the influence of aldosterone, the remainder is eliminated depending on potassium and hydrogen ions concentration. The body eliminates more or less water depending on homeostatic needs of the body. Water reabsorption here is under the control of anti-diuretic hormone (ADH).

Some authors working on urinary concentration capacity of healthy infants observed concentrations of 500-700 mosm/l by the second week of life and up to 896 mosm/l by 2-4 weeks of life (Polaceck et al, 1965). 1088 mosm/l by the age of 4-5 months were reported (Winberg, 1959). According to Almroth, (1978, 1990)) concentrations of 1473 mosm/l by the 35 th day and 1570 at 73 days of life were reported (Pratt et al, 1948 and

Urinary concentration can be approximately estimated from urine specific gravity in the absence of albuminuria and glucosuria (Winberg, 1959) using the equation.

$$X = \frac{Y - 1.000219}{0.0000274}$$

where X = urinary concentration and Y = specific gravity

2.3. RENAL SOLUTE LOAD OF HUMAN MILK

Solutes that must be excreted in the urine are referred collectively to as the renal solute load. With rare exceptions the main contributors to renal solute load are nitrogenous substances and electrolytes. Sugar, a major component of dietary solutes is ordinarily metabolised to carbon dioxide and water and therefore does not contribute to renal solute load. Therefore estimates of renal solute load are based on dietary intake of nitrogen and 3 major electrolytes: sodium, potassium and chloride. Each gram of protein yields 4 milliosmoles of renal solute load and each milliequivalent of potassium, sodium or chloride contributes 1 milliosmole (Ziegler and Fomon 1971).

Although milk provides only 88 ml of preformed water per 100 gm, an additional 8 ml of water will be derived from metabolism of proteins, carbohydates and fats (Ziegler and Fomon 1971). The total volume of water may therefore be assumed to be approximately equal to the volume of milk. Renal solute load should be a major consideration in the choice of feeding infants. It is advisable to give foods with low renal solute load like human milk especially in situations where renal concentrating ability is limited, or where there is low milk volume intake and/or high extra renal fluid loss. See table 2.

Table 2: Estimated renal solute load from various feedings with dietary intake of Na, K, Cl

FEEDING	Dietary intake				Estimated solute load		
	Protein Gm	Na Meq	K Meq	CL Meq	Urea mosm	Na+ Cl- K+	Total
Whole cow milk	33	25	35	29	132	89	221
Human milk	12	7	13	11	48	31	79

(from Fomon and Ziegler, 1971)

From the above table a hypothetical infant receiving approximately 1000 ml of fluid per day and a urine concentration ability limited to 700 milliosmoles/litre and with extra renal loss (sweat, lungs and faeces) of this infant to be 600 ml. When human milk is fed, 79 mosm/l will have to be excreted in 400 ml resulting in urine concentration of 197 mosm/l. The analogous situation with cow milk in the same child will be 221 mosm be excreted in 400 ml giving a urinary concentration of 553 mosm/l (Ziegler and Fomon 1971).

With a similar principle, Almroth in 1978 made calculations using a hypothetical four months old baby with a body weight of 6.3 kg, an energy intake of 103 Kcal/kg. The caloric concentration of human milk of 75 kcal/100 g. The daily milk intake of this baby is 856 ml which is approximately equal to the amount of water available. Given an average value of 89 ml per kg for evaporative water losses and 10 ml per kilogram of faecal water loss, the total water loss would amount to 561 ml and 63 ml respectively. This leaves 241 ml of water for excretion of renal solutes. Given a nitrogen content of human milk of 1.48 mg/ml, the infant would receive 203 mg of nitrogen intake. The urinary excretion of nitrogen is 110 mg/kg and the osmolar load of nitrogen is 110 mg/kg. Hence, the osmolar load of nitrogen calculated as mosm of urea would be 25 mosm. The renal solute load of Na+, K+, Cl- would give an additional 27 mosm. Hence the total will be 52 mosm and the infants urinary concentration will be 216 mosm/l which is very safe.

2.4. EARLIER WORKS ON WATER SUPPLEMENTATION

The first study on water supplementation was carried out by Almroth S.G in 1978 in Jamaica. The mean out-door temperature was 27.6° C and relative humidity 76%. She collected three urine samples each from her 16 exclusively breastfed subjects aged 0-4 months. The urine specific gravities ranged from 1.005-1.015 with a mean of 1.009 and their corresponding urinary concentrations ranged from 103-468 mosm/l with a mean of 258 mosm/l. With exceptions of infants having fever and those in hot and dry areas, she concluded that water supplementation was not necessary.

In 1979, Armelini and Gonzalez in Argentina where the temperature range was 20-39°c and relative humidity 60-80%, worked on 8 exclusively breastfed subjects and collected twelve paired urine samples (afternoon and night). The night urinary concentration ranged between 113-160 mosm/l with a mean of 137 mosm/l while that of the days ranged between 118-199 mosm/l with a mean of 171 mosm/l. They concluded that water supplementation was not necessary because none of these infants reached maximum concentration for age. Exception here were children with fever and /or limited breastmilk intake.

In 1982 Golberg and Adams working in Sinai desert Israel on 15 healthy exclusively breastfed infants 0-5 months old reported osmolality range of 55-320 mosm/ with a mean of 164.5. From these results they inferred that water supplementation was not necessary. Temperatures here ranged from 32-37°c with of mean 33°c and relative humidity, 13-41% with a mean of 26.7%

Keneth et al in 1984 reached similar conclusions in Peru where temperatures varied between 26-33°c and relative humidity 49-96% with a sample size of 40 infants. The urine specific gravities ranged from 1.003 to 1017 with their corresponding concentrations of 30-544 mosm/l.

In 1985 Almroth and Bedinger worked in Andhrah Predesh India under a temperature range of 35-40°c and relative humidity 10-35%. They had a sample size of 31 infants below 6 months and 13 infants between 6-10 months. Urine specific gravities readings ranged from 1.004 - 1.036 in infants less than 6 months old. Their corresponding urinary osmolalities range was 66-1234 mosm/l and 103-978 mosm/l respectively. They concluded that water supplementation was not necessary since none of this infants reached maximum concentration for age. Another interesting finding was the high level of water contamination in their study area.

In 1991 Sachdev et al reached similar conclusions in the same country India under a temperature range of 34-41°c and relative humidity of 9-60%. They worked on 45 male infants in an infant welfare clinic. These children were allocated to two groups one serving as a control group of the other. The maximum urinary concentrations reached were 700-703 mmol/kg for the study group and 478-636 mmol/kg for control group. They found no significant difference between the two groups in urinary output, urine specific gravities (or concentrations) and weight. A conclusion was then drawn that water supplementation was not necessary. Moreover they observed that infants receiving supplemental water had a reduced milk intake which is a nutritional threat. See table 3 for summary of studies on water supplementation

Table 3: Summary of studies on water supplementation

Country	Temp (°.c)	Humidity (%)	Number of infants	Age (months)	N° of urines samples	Osmolalities mosm/l
Jamaica [a]	24-28	62-90	16	0,5-4	48	103-468
Argentina [b]	20-39	60-80	8	0,5-2	24	105-199
Israel [c]	32-37	13-41	15	1-5	15	55-320
Peru [d]	26-33	45-96	40	0,2-6	40	30-544
India [e]	35-40	10-35	31	1-5	63	66-1234
			13	6-10	28	103-978
India [f]	34-41	9-60	gp I 23	1-6	?	703
			gp II 22	1-6	?	≤ 468

a Almroth Stina (1978)
b Armelini & Gonzalez (1979)
c Goldberg & Adams (1983)
d) Kenneth et al (1986)
e) Almroth and Bedinger (1990)
f) Sachdev et al (1991)

CHAPTER 3

OBJECTIVES

3.1. GENERAL OBJECTIVES

To asses the benefit and risk of water supplementation in exclusively breastfed infants aged 0-6 months in a hot and dry region of Cameroon.

3.2. SPECIFIC OBJECTIVES

To investigate the beliefs and practices of water supplementation in exclusively breastfed infants aged 0 to 6 months in the study area population.

To compare two groups (A and B) of infants by using their urine specific gravities (or urine concentrations) and urine output: group A comprised infants exclusively breastfed and group B comprised infants breastfed and receiving supplemental water according to their usual habits.

To determine the extent and nature of contamination of water samples collected systematically in the study area.

From the results to elaborate a health education plan.

DEFINITION OF TERMS

1. WATER SUPPLEMENTATION

Giving water to a healthy baby in addition to breastmilk to meet up with water needs of the baby.

EXCLUSIVELY BREASTFED

Receiving only breast milk as the only source of nutrition.

CHAPTER 4

METHODOLOGY

4. 1. STUDY DESIGN

The work was a comparative, experimental, analytical, cross sectional and prospective study that lasted one month.

4.2. STUDY PERIOD

The study took place from April 7 to May 5 th 1991.

4.3 PLACE OF STUDY

The study took place in the Far North Province (one of the hottest and driest provinces) of Cameroon, precisely in 5 villages located between 6 and 35 kilometres west of Maroua, the provincial capital. The villages were Kaliao, Houdouvou, (in Meri Sub division), Zokok, Ladewo and Jawaro (Maroua central).

Like in most parts of the country there are two seasons, the dry season from October to April and rainy season from May to September. Day time temperatures varied between 28°C and 45° C while night temperatures were lower. Relative humidity ranged between 13-55% in the days and higher in the night. The vegetation is of the Savannah type with shrubs dotted here and there. The land is level in most areas and hilly in a few places.

The main economic activities of the men are cattle rearing, weaving and craftmanship. They also cultivate crops like millet, cassava and corn . Most of the women are only limited to domestic activities. Nursing mothers are always around their babies. A few women do farming around their homes. Meri subdivision has a population of 64.000 people with a land area of 135 km^2. Kalliao the main area of study has a population of 4100 people while Houdouvou and Zokok follow with 3000 and 455 people respectively.

About 70% of the inhabitants in this areas are muslims, 20% are . christians and 10% are animist. The principal language is Fufulde. The main tribes are Guizuiga, Fulbe, Ouhou and Mada. Three of the villages had no school. More than 90% of the population are illiterates. All the villages have a health post which is more of a monument than a place rendering health services due to lack of drugs. The subdivisional headquarter Meri, has a hospital. None of the villages has electricity or

pipe-borne water. Two villages have a hand pump well each. Most of the population depend on open well water or river water.

4.4. SUBJECTS AND MATERIALS

4.4.1. Study population

Our study population comprised children aged 0-6 months

4.4.2. Criteria of inclusion

- aged 0-6 months
- must be in good health (no obvious disease)
- mother in good health
- breastfeeding
- verbal consent from parents

4.4.3. Criteria of exclusion

- age greater than 6 months
- illhealth of baby or mother
- refusal of consent by parents
- artificial feeding (bottle feeding).

4.4.4. Sample size

Taking into account that water supplementation could induce a difference (Δ) of 0.002 of urine specific gravity, a study power of 95% and considering type 1 error of 5% and a former study SD (σ) of 0.002, our sample size was calculated using the equation according to Laplanche, et al, (1987)

$$n = \frac{2\sigma^2}{\Delta^2} (M), \text{ or } n = m/\Delta\sigma^2,$$

The value of M is got from table 2 (Laplanche et al, 1987).

Our calculated sample size was 50 and we allocated these infants into two groups of 25 each.

4.4.5. Materials

- weighing scale	"salter"
- measuring cylinder	
- clinistix	"Ames England"
- albustix	-"-
- oto-rhino-laryngoscope	
- measuring tape	
- stethoscope	
- plastic adhesive urine collector bags (u-bags)	Hollister Illinois USA
- thermometer	
- hair hygrometer	Berigo Germany
- refractometer	Schuco Williston park New york USA.
- sterile collector bottles	(Pasteur)
- incubator	
- sterile plastic petri dishes	
- sterile test tubes	
- sterile pipettes	(Pasteur)
- Sterile pipettes	(2 ml capacity)
- colony counter	
- water bath	

Culture media:

- PCA agar (standard agar for enumeration)
- Barid parker
- lactosed agar in TTC and Tergitol 7
- lactosed and sacharosed agar in eosine and methylene blue (EMB agar)
- Trypto-sulfito-neomycine agar (TSN)
- Endo agar
- Bile Esculine.

4.5.1. PROCEDURE

After seeking verbal consent from administrative authorities and parents of the study area, we selected 5 villages on the basis of: population, accessibility and willingness of the parents to participate in the study. We revisited each of the 5 villages in turn, recruited and programmed infants eligible for the study. We had 24 infants in Kaliao, 8 in Houdouvou, 8 in

Zokok, 8 in Ladewo and 2 from Jawaro. In all, 50 healthy infants who fulfilled the inclusion criteria were recruited and programmed for the study. The infants were divided into two groups of 25 each. Group A comprised infants breastfed exclusively and Group B infants breastfed and given supplemental water from cups of known volume according to their pre-study habits.

Exclusively breastfed infants at the time were automatically enrolled in group A while the rest were randomly allocated to either group. Group A mothers who were not practising exclusive breastfeeding accepted to discontinue supplementation during the study period (24 hrs).

Four children (2 from each group) averagely were studied every two days. At the beginning of each study period, a thorough physical examination was conducted during the morning hours to exclude any medical disorder that could disqualify the child from the study. Likewise, we made sure that the mothers were in good health. Relevant details of the baby were taken as well as reminding the mothers to respect the rules of the study from that evening to the next evening. Parents and some health workers around were also interviewed about the rationale for water supplementation.

A pre-study urine collection was done using self adhesive plastic urine collector bags (u-bags) on the evening prior to 24 hrs of the study. The following day, urine collection was done on three occasions (morning, afternoon and evening) in homes of the infants. The author walked from house to house putting the u-bags on the perineum of these infants between 8 and 830 am, he then returned later to collect the u-bags and place new ones on the infants perineum at 11 h and 14h . The 3rd urine samples were collected at 18 h.

In all, 192 urine samples were collected (100 from group A and 92 from group B) and volumes recorded from a measuring cylinder. Before proceeding to specific gravity readings, the urine was tested to eliminate albuminuria and glucosuria. The specific gravity was got by placing a drop of urine on a hand held clinical refractometer and reading out the value directly.

The daily indoor and outdoor temperatures and relative humidities were recorded every two hours from 8 am to 6 pm using an ordinary room thermometre and a hair hygrometer respectively.

17 water samples were taken by systematic sampling (1 sample from every 3rd house) of the 50 homes to test for bacterial contamination. After washing hands with soap, water was collected aseptically using clean and sterile collector bottles provided with a stopper. The bottles were provided by Centre Pasteur.

Water collection was done with a lot of precaution. We made sure that the stopper was only removed when the sample was about to be collected and once removed was not laid down or allowed to touch anything. During filling, we made sure that the water came in contact only with a sterile inner part of the bottle. During filling, the bottles were held at the base to avoid touching its neck. Once all the water samples were collected, they were put in a sterile plastic container and immediately transported to Yaoundé by air (11/2 hr journey). On arrival, they were taken to Centre Pasteur du Cameroun laboratory Yaounde without delay. for bacteriological analysis using standard methods.

Each water sample after shaking to mix, we made serial dilutions 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} in sterile test tubes using sterile distilled water. 1 ml of each final dilution was put in a culture media for culturing of the germs found in the water.

- Total anaerobic germs were cultured in PCA agar at 30°C for 48 hrs
- Total coliformes were cultured in lactose agar in TTC-Tergitol 7 at 37°C during 24 hrs.
- Fecal coliformes cultured using endo culture medium at 44°C for 24 hrs.
- Fecal streptococci using BEA culture medium for 48 hrs at 37°C.
- Staphylococcus on Barid parker culture medium.
- Anaerobic sulfito reducers using TSN culture medium at 44°C.

After incubation, the germs were counted using a colony counter. The colonies were isolated and identified using the API 20E system (API 20E entero for enterobacteria and API 20 pseudo for pseudomonas.

Statistical analysis was done using a Student-test and chi square test.

CHAPTER 5
RESULTS

THE RESULTS SHALL BE PRESENTED AS FOLLOWS:

- BELIEFS AND PRACTICES ON WATER SUPPLEMENTATION
- CLINICAL CHARACTERISTICS AND ENVIRONMENTAL CONDITIONS
- URINE SPECIFIC GRAVITIES AND URINARY CONCENTRATIONS
- WATER INTAKE AND URINE OUTPUT
- RATE OF WATER CONTAMINATION AND CONTAMINANTS.

TABLE 4: BELIEFS AND PRACTICES ON WATER SUPPLEMENTATION

Question / Response	Mothers n = 56	Doctors n = 2	Nurses n = 6	Village health worker n = 12	Paramed personnel n = 4
Breastmilk nutritionally adequate up to:	n (%)	n (%)	n (%)	n (%)	n (%)
0 month	36 (64)	1 (50)	4(67)	8 (67)	3 (75)
1 month	5 (9)	1 (50)	1 (6)	2 (17)	1 (25)
2 months	4 (7)		1 (16)	1 (8)	
3 months	3 (5)			1 (8)	
4 months	6 (11)				
5 months	1 (1.8)				
6 months	1 (1.8)				
Water supplementation of breastfed infants is necessary from:					
0 month	36 (64)		5 (83)	9 (75)	3 (75)
1 month	5 (9)	1 (50)	1 (17)	1 (8)	1(25)
2 months	5 (9)	1 (50)		1 (8)	
3 months	6 11)			1 (8)	
4 months	3 (5)				
5 months	1 (1.8)				
6 months					
Average number of water supplements a day					
3	30 (53)	1 (50)	5 (83)	3 (25)	
4	8 (14)	1 (50)		5 (42)	
5	4 (7)			1 (8)	1 (25)
6	4 (7)				1 (25)
on demand	10 (18)		1 (17)	3 (25)	2 (50)

The results of table 4 show that 64% of mothers and 71% health personnel interviewed believed that water supplementation was necessary from birth. Exclusive breastfeeding after four months was extremely rare. Most people agreed that three water supplements daily was satisfactory.

TABLE 5: CLINICAL CHARACTERISTICS

VARIABLE	GROUP A	GROUP B
INFANTS		
- AGE (months)		
Mean	2.9	3.1
STD DEV	2.1	2
- WEIGHT (kg		
Mean	5.5	5.4
STD DEV	1.6	1.5
- HEIGHT (cm)		
Mean	59	58
STD DEV	6.3	6.8
- MID ARM CIRCUMFERENCE		
Mean	14.6	14.8
STD DEV	1.2	1.3
- SEX		
N° of females	12	9
N° of males	13	16
- N° WITH A PAST HISTORY OF DIARRHOEA SINCE BIRTH	13	10
- SOURCE OF DRINKING WATER		
Hand pump well	7	3
Others (open well, river)	13	22
- DAILY N° OF WATER SUPPLEMENTS		
Mean	4.3	4.7
STD DEV	0,9	0,9
- N° DRINKING BOILED WATER	2	3
MOTHERS		
- AGE (years)		
Mean	24.5	24.4
STD	6	5.4
- LEVEL OF EDUCATION		
Never went to school	24	24
Never completed primary school	1	1

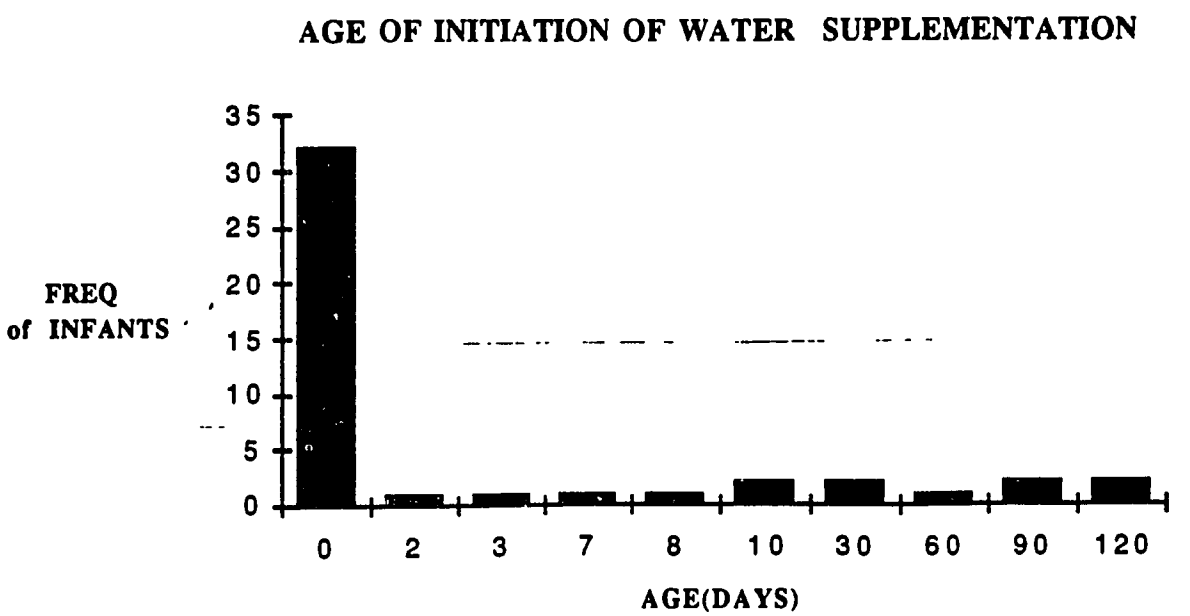
The results of table 5 show that the two groups were homogeneous and met up with our study criteria. Five children were exclusively breastfed before the study. 23 infants had a past history of diarrhoea. 35 infants drank either from open well or river water. No infant was malnourished.

TABLE 6: ENVIRONMENTAL CONDITIONS

VARIABLE	GROUP A	GROUP B
- AMBIENT TEMPERATURE (°C)		
RANGE	28-45	28-45
MEAN	37	37
- AMBIENT RELATIVE HUMIDITY (%)		
RANGE	13-55	13-55
MEAN	28	28

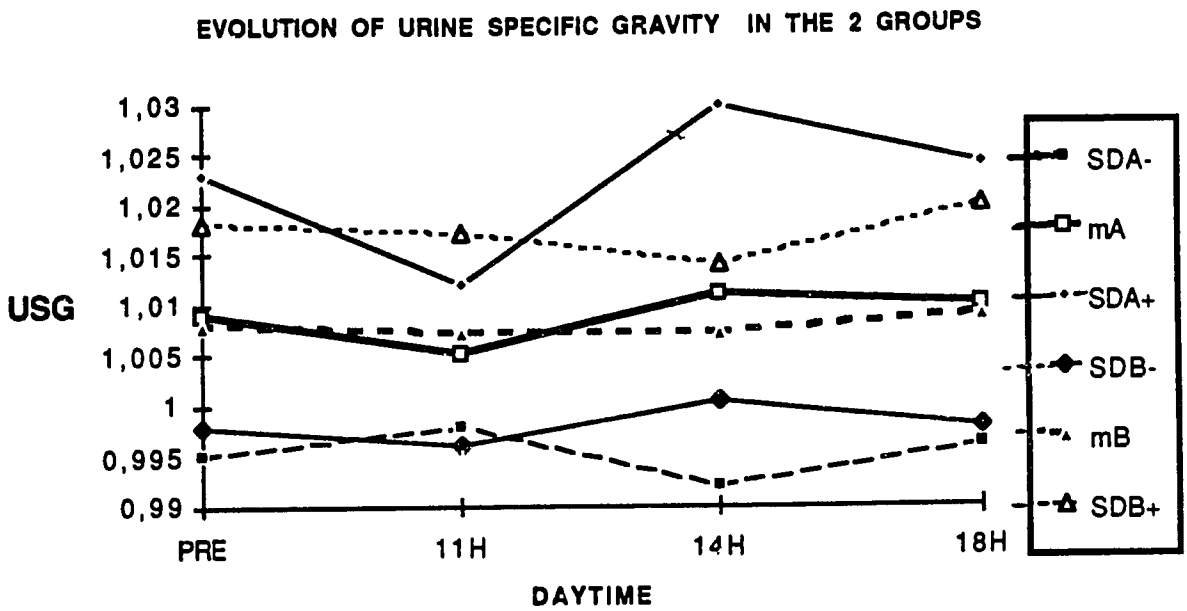
It can be seen from table 6 that temperatures were generally high during the study period with a mean of 37° C. The climatic conditions were similar for both groups.

FIGURE 1: AGE OF INIATION OF WATER SUPPLEMENTATION



This figure shows that water supplementation is started mostly at birth.

FIGURE 2: DAILY EVOLUTION OF SPECIFIC GRAVITY IN THE 2 GROUPS



SDA- = Mean - 2 SD of USG in group A

mA = Mean USG in group A

SDA+ = Mean + 2 SD of USG in group A

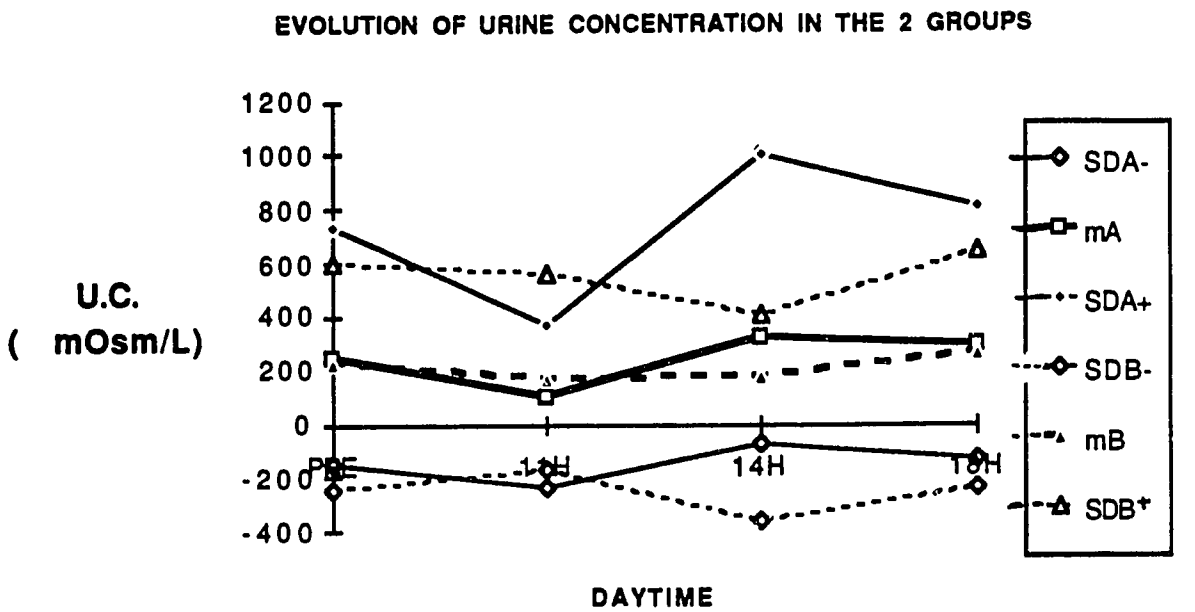
SDB- = Mean - 2 SD of USG in group B

mB = Mean USG in group B

SDB+ = Mean + 2 SD of USG in group B.

The evolution of urine specific gravities were similar in the two groups and showed no significant difference ($p \geq 0.14$) even during the hottest part of the day.

FIGURE 3: EVOLUTION OF URINE CONCENTRATION IN THE 2 GROUPS



SDA- = Mean - 2 SD of UC in group A

mA = Mean UC in group A

SDA+ = Mean + 2 SD of UC in group A

SDB- = Mean - 2 SD of UC in group B

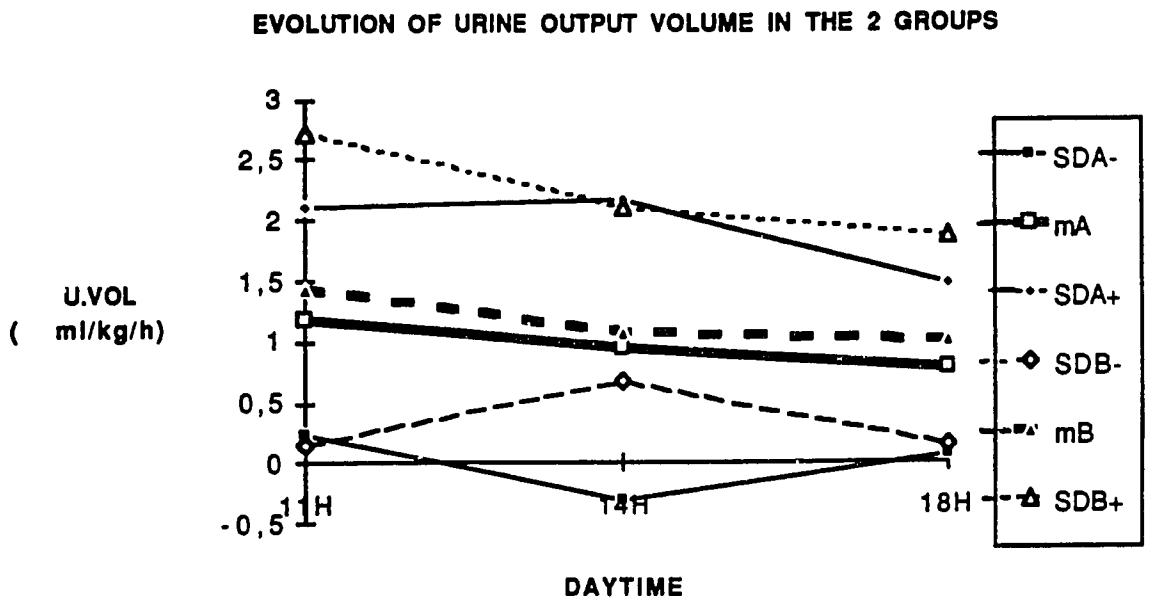
mB = Mean UC in group B

SDB+ = Mean + 2 SD of UC in group B.

The urine concentrations are just mirror reflections of urine specific gravities.

The minimum water intake in group B was 20 ml and maximum 280 ml with a mean of 104 ± 46 ml during the 10 hours period.

FIGURE 4: DAILY EVOLUTION OF URINE OUTPUT VOLUME IN THE 2 GROUPS



SDA- = Mean - 2 SD of u. vol in group A

mA = Mean u. vol in group A

SDA+ = Mean + 2 SD of u. vol in group A

SDB- = Mean - 2 SD of u. vol in group B

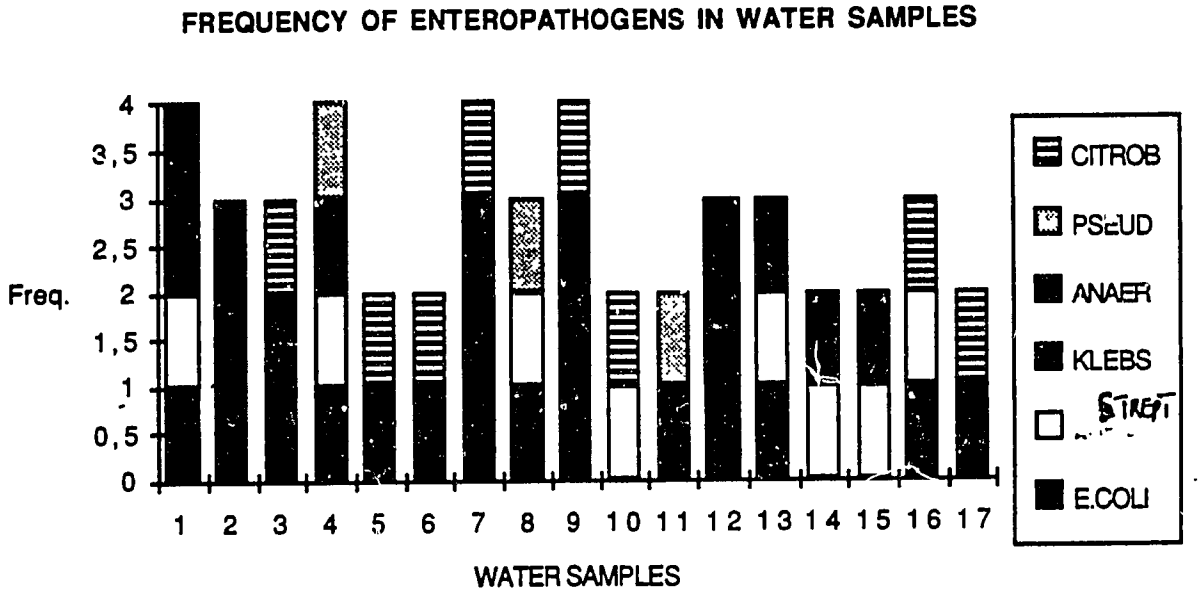
mB = Mean u. vol in group B

SDB+ = Mean + 2 SD of u. vol in group B.

The evolution of urine output volume in the two groups were similar and showed no significant difference ($p \geq 0.39$) at anv time of the day.

FIGURE 5: FREQUENCY OF ENTEROPATHOGENS IN THE 17 WATER SAMPLES

Num	Ecoli	Klebsiel	Citro	Pseudo	Strept	Anaerobi
1	+	+	-	-	+	+
2	+	+	-	-	-	+
3	+	-	+	-	-	+
4	+	-	-	+	+	+
5	+	-	+	-	-	-
6	+	-	+	-	-	-
7	+	+	+	-	-	+
8	+	-	+	+	+	-
9	+	+	-	+	+	-
10	-	+	+	-	+	+
11	-	-	+	-	+	-
12	+	+	+	+	-	-
13	+	-	-	-	+	+
14	-	-	-	-	+	+
15	-	+	-	-	+	-
16	+	+	+	-	-	-
17	-	-	+	+	-	-



CITROB = Citrobacter ANAER = Anaerobes
PSEUD = Pseudomonas KLEBS = Klebsiella
STREPT = Streptococcal faecalis E. COLI = Escherichia coli

All the 17 water samples were contaminated with at least 2 types of Enteropathogens E. coli is the most prevalent.

CHAPTER 6

DISCUSSION

Previous studies carried out in other arid and hot areas of the world have shown that water supplementation of exclusively breastfed infants aged 0 to 6 months is not necessary(Kenneth et al, 1984; Almroth and Bedinger, 1990; Sachdev et al, 1991). Nevertheless, no comparative study had been done in the community and in a Sub -Saharan region.

Considering the high prevalence of water supplementation in exclusively breastfed infants aged 0 to 6 months in the African Sub-Sahara countries, it was interesting to replicate and improve on what has been done elsewhere on this subject. In this light, the aim of this work was to conduct a comparative field study on this subject to assess the benefit and the risk of water supplementation for exclusively breastfed infants in Meri Maroua (a Sahelian part of Cameroon) where ambient temperatures were generaly high during the day with a mean of 37°C. Outdoor temperatures were generally low in the morning, peaked between noon and 3.00 pm and dropped gradually to minimum values in the night. In contrast, the relative humidity was greatest in the morning, dropped sharply between noon and 4.00 pm to very low values and increased steadily to higher values in the night. The mean relative humidity was 28%. The data show that this area is very hot and dry and is comparable to those reported in India (Sachdev et al 1991, Almroth and Bedinger, 1990). The data imply a high extra renal loss.

The first issue of this work is to underline the magnitude of water supplementation as a common practice in the study area. In fact there is abundant evidence from the results that water supplementation is highly practised in this area. It is also obvious that this practice is started mostly at birth. In our study 64% of mothers and 71% of paramedical and medical personnel interviewed, encouraged water supplementation from birth. The data indicates the acuteness of the problem because a high percentage of medical personnel encouraged water supplementation.

This malpractice is done in many developing countries such as India (Sachdev et al, 1991), Peru (Kenneth et al, 1984) and most of African Sub-Sahara countries (Lomé forum, 1991). Water suppelementation is generally practised with the conception that it will increase fluid intake and thereby improve hydration status. However this wrong conception is on the basis of caution rather than knowledge on the subject as scanty literature exists on the subject. Moreover there is evidence that water supplementation may reduce milk output of mothers, milk intake of infants and eventually may lead to early termination of breastfeeding due to absence or reduced

early termination of breastfeeding due to absence or reduced suckling reflex (Jeffcoate, 1975; Sachdev et al, 1991) a health hazard on its own as malnutrition may set in.

From results, 90% of the infants were receiving water supplements before recruitment for the study. This value is higher than those observed in other developing countries such as India (80%, 50%) and Peru (70%) as reported by Sachdev et al (1991) and Kenneth et al (1984) respectively. Therefore it can be deduced from our data that water supplementation is a more frequent practice here than in other areas and requires health education of both the health personnel and the community as both expressed ignorance on the subject.

The second issue of the study is that the results confirm those of previous studies showing that there is no obvious benefit in offering supplemental water to exclusively breastfed infants aged 0 to 6 months . Nevertheless, it is of interest to have carried out such a comparative clinical trial in the field rather than in the hospital.

Urine specific gravity, urine concentration and urine output volume (diuresis) are considered as simple and reliable methods of assessing the hydration status of individuals (Pratt et al, 1948; Winberg, 1959; Polaceck et al, 1965; Ziegler and Fomon, 1971 and Almroth, 1990). However it could have been interesting to know the milk intake of these infants in such a study but this could not be accomplised due to lack of sensitivity of the weighing scale used.

The mean (SD) urine specific gravities in the morning in group A and group B were comparable and showed no significant difference ($p = 0,42$) between the two groups and even those in the afternoon (the hottest period of the day) showed no significant difference ($p = 0,14$) and finally those in the evening were similar with no significant difference ($p = 0,4$) between the two groups see figure 3. The corresponding urine concentrations were just mirror reflections of the specific gravities.

The maximum specific gravity (urine concentration) in group A was 1036 (1234 mosm/l) and 1027 (905 mosm/l) in group B. 8 infants (5 from group A and 3 from group B) had urinary concentrations above 700 mosm/l. All these infants were aged ≥ 4.5 months. Only 2 infants in group A (aged 4.5 and 6 months) and 1 infant in group B (aged 5 months) had urinary concentrations greater than 900 mosm/l. The only infant who had a

urine concentration of 942 mosm/l in the evening. Similar values were reported in India (Almroth and Belinger, 1990). Even the above mentioned maximum urine concentrations were below maximum urine concentration for age as higher values for age have been documented in literature by earlier researchers (Pratt et al, 1948, Winberg, 1959; Polaceck et al, 1965).

In addition, despite a mean (SD) of 104 (± 46 ml) of ingested supplemental water in group B, the hydration status remained similar as urine volume output showed no significant difference at any time of the day between the two groups ($p \geq 0.39$). The mean (SD) urine output volume for group A and group B were respectively 44 (± 17) ml and 54 (± 18) ml and can also be expressed as 1 ml/kg/h in group A and 1.22 ml/kg/h in group B.

Finally, these results bring out another important consideration. There is considerable risk associated with water supplementation as was demonstrated that all the systematically collected water samples were contaminated with bacteria. The water was neither tested for parasitic nor viral contamination. Bacterial load ranged from 10^2 - 2 x 10^6/100 ml. *E. coli* and Klebsiella were the most frequent. The presence of enteropathogens clearly signifies that there was faecal contamination due to poor hygiene. We did not test for the pathogenicity of the bacteria.

Enteropathogens are highly implicated in the aetiology of infantile diarrhoea which in turn is among the first causes of infant morbidity and mortality in our country and other developing countries (Pritech/Sahel, 1989, Bulletin du Centre Int. 1989). Diarrhoea is a public health problem in the study area as 46% of our infants had past histories of diarrhoea. This high value is not suprising as a rate of 2.4 diarrhoeal episodes per child per year had earlier been reported in our country by the Cameroon Ministry of Public Health 1988-1989 and higher rates were reported in the developing countries by WHO (1989).

CHAPTER 7

CONCLUSION

This study confirms the results of previous studies on the subject showing that water supplementation offers no benefit to exclusively breastfed infants aged 0 to 6 months. Moreover, in poor hygienic conditions, water supplementation constitutes a dangerous source of enteropathogens potentially responsible for infantile diarrhoea.

Our study hypothesis has been proven right.

CHAPTER 8

RECOMMENDATIONS

1 Education of health personnel on exclusive breastfeeding of infants in the first 4 to 6 months of life and the risk associated with water supplementation in infants of this age group.

2 Community health education on exclusive breastfeeding of infants in the first 4 to 6 months of life and the risk of infection associated with water supplementation.

3 Educate and encourage mothers to exclusively breastfeed their babies till the age of 4-6 months and to adequatly diversify the food of their babies after the said age and to boil all drinking water.

4 Promotion of the Innocenti declaration (WHO 1990) which states that governements should recommend exclusive breatfeeding in their national health policy.

5 The improvement of water supply sources in the study area by the Government.

6. A similar study be carried out in other areas of the country by other researchers.

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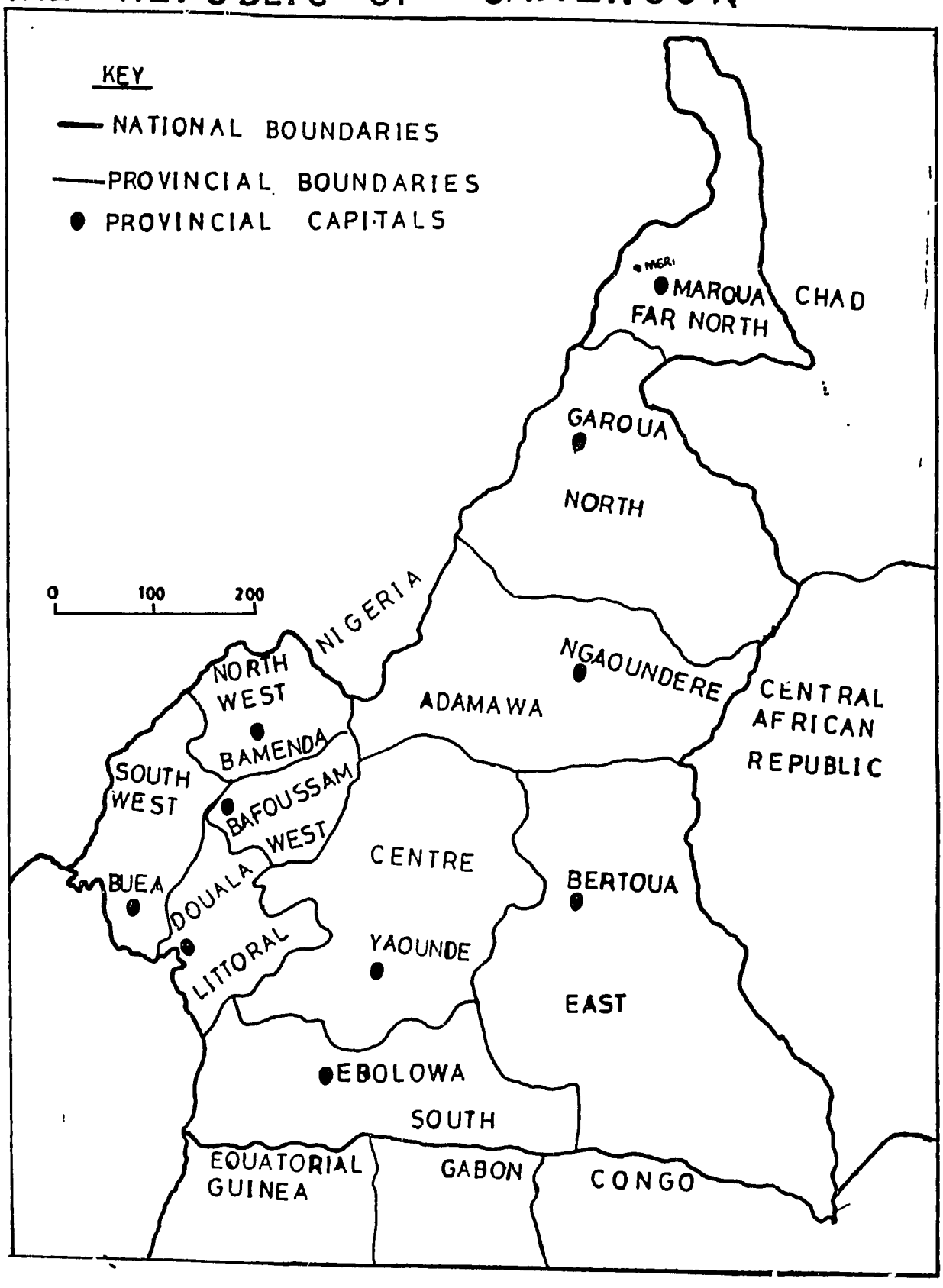
APPENDICES

- Map of the Republic of Cameroon
- Map of MERI Sub-Division (Diamaré Division).
- The Hypocratic Oath, Declaration of Geneva.
- Questionnaire on water supplementation of exclusively breastfed infants aged 0 to 6 months.
- Some interesting photographs of the study area.
- Laboratory results.

THE REPUBLIC OF CAMEROON



EY :

- Provincial Head Quarter.
- Sub-Divisional Head Quarter.
- District «Canton».
- Village.
- Secondary Road

THE HIPPOCRATIC OATH, DECLARATION OF GENEVA

At the time of admission as a member of the medical profession:

I solemnly pledge myself to consecrate my life to the service of humanity;

I will give my teachers the respect and gratitude which is their due;

I will practise my profession with conscience and dignity;

The health of my patient will be my first consideration;

I will respect the secrets which are confided in me, even after the patient has died;

I will maintain by all means in my power the honour and the noble traditions of the medical profession;

My colleagues will be my brothers;

I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient;

I will maintain the utmost respect for human life from the time of conception; even under threat I will not use my medical knowledge contrary to the laws of humanity;

I make these promises solemnly, freely and upon my honour. (Declaration of Geneva "Physicians oath Declaration" adopted by the Geneva Assembly of the World Medical Association at Geneva, Switzerland, September, 1948 and amended by the 22nd World Medical Assembly, Sydney, Australia - August, 1968).

QUESTIONNAIRE ON NEED OR NOT OF WATER SUPPLEMENTATION IN INFANTS AGED 0-6 MONTHS FOR ADEQUATE HYDRATION.

IDENTIFICATION No .....

NAME ..... Sex

Age ..... Tribe .....

PAST HISTORY

Any diarrhoea since delivery Yes ☐ No ☐

If yes precise number.

Physical exam

. Weight
. Head-Neck
. Chest
. Abdomen
. Limbs

Brachial perimetre .....

HEIGHT ...

Mother

Name ..... Age ..... Tribe .....

Level of education ..... Profession .....

When was breast feeding initiated .....

If late precise reasons

Any supplement Yes ☐ No ☐

If yes, precise, water ☐ Millewater ☐ Pap ☐

Do you boil the water...

When was water initiated

How often does child drinks daily

What period .....

What type of water Mayo ☐ Forage ☐ Puit ☐

Date	No	S.G	Con	To	Hu	Time	Vol		Remark
							Intake	Output	

Water sample ? *YES* /__/ *NO* /__/

If YES CONTAMINATED ? *YES* /__/ *NO* /__/

If yes precise contaminants

INTERVIEW

NAME: .....

ADDRESS: .....

Breastmilk nutritionally adequate up to .....

Water supplementation of exclusively breastfed infants aged 0 to 6 months is necessary from .....

Number of water supplements necessary per day .....

78'

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Tél : 23-10-15 — 23-16-03

Yaoundé, le - 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N°

Prélèvement :

Lieu :

Eau de : Boisson

Prelevée le :

Transport :

Reçu le à heures

Référence : Dorjo 3 mois

Non traitée Traitée par :

à heures

Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 16 000 00 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 13000 00 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 10400 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Pseudomonas Eau non potable

-49

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le à heures

Prélèvement :

Lieu : Référence : ~~Sonda~~ Cameroun 4 mois

Eau de : Boisson Non traitée Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1.000 000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 600.000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 6400 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : +++ spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de nombreux germes : Escherichia coli
Pseudomonas, Enterobacter cloacae
Anaérobies sulfito réducteurs

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le à heures

Prélèvement :

Lieu : Référence : Ous mala 6 Mois

Eau de : Boisson Non traitée Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 119000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 64000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 8100 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 10 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Klebsiella pneumoniae, Anaérobies sulfito-réducteurs Eau non potable

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Yaoundé, le

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le à heures

Prélèvement :

Lieu : Référence :

Eau de : Boisson Non traitée Traitée par : Hawa 27 jours

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies à 30° : 17000 00 par 100 ml (/1)

2° Dénombrement des coliformes totaux à 37° : 600300 par 100 ml (/1)

3° Dénombrement des coliformes fécaux à 44° : 3600 par 100 ml (/1)

4° Recherche des Streptocoques fécaux à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs à 47°C : 4 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Enterobacter cloacae, Pseudomonas,
Anaérobies sulfito réducteurs,
Eau non potable.

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence :

Eau de : Boisson Non traitée Traitée par : Sabure 16 j

Prélevée le : heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 700000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 48000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 0 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes
Klebsiella pneumoniae
Enterobacter cloacae
Eau à traiter

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Yaoundé, le

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : Aminatou 5 Mois

Eau de : Boisso Non traitée Traitée par : heures

Prelevée le :

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1 400.000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 900.000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 1 300 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes

CONCLUSION

Présence de nombreux germes : Escherichia coli
Pseudomonas, Klebsiella pneumoniae
Eau non potable

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Yaoundé, le 10 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Prélèvement : Reçu le heures

Lieu : Référence : yamoudam 5 rois

Eau de : boisson Non traitée Traitée par :

Prelevée le : heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies à 30° : 400000 par 100 ml (/1)

2° Dénombrement des coliformes totaux à 37° : 170000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux à 44° : 25600 par 100 ml (/1)

4° ~~Recherche des~~ Streptocoques fécaux à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs à 47°C : 6 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de nombreux germes : Escherichia coli
Pseudomonas, Klebsiella pneumoniae
Anaérobies sulfito réducteurs
Eau non potable

55

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : Jon maron 3mois 1/2

Eau de : Boisson Non traitée Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 3.000.000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 1200 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Citrobacter freundi Enterobacter cloacae
Eau non potable

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Yaoundé, le 8 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : A Damou 2mois

Eau de : Boisson Non traitée Traitée par : heures

Prelevée le :

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 260000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 200000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 0 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Pseudomonas
Enterobacter cloacae.
Eau à traiter

-57.

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Yaoundé, le 10 MAI 199

ANALYSE BACTERIOLOGIQUE DES EAUX

A N A L Y S E C O M P L E T E

N°

Prélèvement :

Lieu :

Eau de : Bouson

Prelevée le :

Transport :

Reçu le heures

Référence : Donbarama 5 Rois

Non traitée Traitée par :

à heures

Température ambiante dans la glace

R E S U L T A T S

1° Dénombrement total des germes aérobies
à 30° : 114000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 100000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 0 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

C O N C L U S I O N

Présence de germes : Klebsiella pneumoniae
Pseudomonas
Enterobacter cloacae

Eau à traiter

58

REPUBLIQUE DU CAMEROUN
PAIX - TRAVAIL - PATRIE

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REPUBLIC OF CAMEROON
PEACE - WORK - FATHERLAND

Yaoundé, le 6 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Prélèvement :
Lieu :
Eau de : Boisson
Prelevée le :
Transport :

Reçu le à heures
Référence : Sanson 9 jours
Non traitée Traitée par :
à heures
Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies à 30° : 2.900.000 par 100 ml (/1)

2° Dénombrement des coliformes totaux à 37° : 1.300000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux à 44° : 12000 par 100 ml (/1)

4° Recherche des Streptocoques fécaux à 37° : — par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de nombreux germes donc Escherichia coli . Pseudomonas

Eau non potable

REPUBLIQUE DU CAMEROUN
PAIX - TRAVAIL - PATRIE

REPUBLIC OF CAMEROON
PEACE - WORK - FATHERLAND

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Yaoundé, le 11 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : Savila 6 mois

Eau de : Boisson Non traitée Traitée par :

Prelevée le : heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 700000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 15 1000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 6800 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : +++ spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Klebsiella, Pseudomonas, Anaerobies
sulfito réducteurs
Eau non potable

60

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Yaoundé, le [illegible] 199[illegible]

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : Wahabore 2 mois

Eau de : Boisson Non traitée Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1500000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 700000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 7700 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 10 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli
Anaerobies sulfito réducteurs, Pseudomonas
Eau non potable

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Yaoundé, le 10 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le heures

Prélèvement :

Lieu : Référence : Fatimyatou 2 mois 39 jours

Eau de : Boisson Non traitée ... Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1970000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 500000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 0 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : 0 spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Klebsiella pneumoniae
Pseudomonas
Eau à traiter

-62-

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le à heures

Prélèvement :

Lieu : Référence : INAMA 4 Mois

Eau de : Boisson Non traitée Traitée par :

Prelevée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1.200.000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 900.000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 19.200 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : — 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : +++ spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de germes : Escherichia coli, Enterobacter cloacae, Klebsiella pneumoniae, Anaerobies sulfito réducteurs.
Eau non potable.

-63

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ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N°

Prélèvement :

Lieu :

Eau de : Bosson

Prelevée le :

Transport :

Reçu le heures

Référence : Habiba 40 jours

Non traitée Traitée par :

à heures

Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies à 30° : 125000 par 100 ml (/1)

2° Dénombrement des coliformes totaux à 37° : 54000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux à 44° : 10500 par 100 ml (/1)

4° Recherche des Streptocoques fécaux à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs à 47°C : +++ spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de nombreux germes : Escherichia coli Klebsiella pneumoniae, Anaerobies sulfito réducteurs Eau non potable

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Yaoundé, le 10 MAI 1991

ANALYSE BACTERIOLOGIQUE DES EAUX

ANALYSE COMPLETE

N° Reçu le à heures

Prélèvement :

Lieu : Référence : Nouva 5 Rois

Eau de : Boisson Non traitée Traitée par :

Prelavée le : à heures

Transport : Température ambiante dans la glace

RESULTATS

1° Dénombrement total des germes aérobies
à 30° : 1.000000 par 100 ml (/1)

2° Dénombrement des coliformes totaux
à 37° : 900000 par 100 ml (/1)

3° Dénombrement des coliformes fécaux
à 44° : 16800 par 100 ml (/1)

4° Recherche des Streptocoques fécaux
à 37° : 0 par 50 ml (/1)

5° Recherche des germes sulfito-réducteurs
à 47°C : + + + spores dans 20 ml (/1)

6° Recherche de Salmonelles 0

7° Recherche de Staphylocoques pathogènes 0

CONCLUSION

Présence de nombreux germes : Escherichia coli
Klebsiella pneumoniae, Enterobacter
cloacae Eau non potable
Anaérobies sulfito réducteurs

PHOTO 1: ZOKOK women with their babies at a recruitement session.

PHOTO 2: Community labour in KALIAO, digging of a dry river bed to fetch water.