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EDITORIAL

PELLARGA IS STILL WITH US

Pellagra which literally means "rough skin" is a nutritional disorder attributed to the consumption of maize by the poor. It is now known that pellagra is a nutritional disease due to deficiency of niacin (nicotinamide), sometimes referred to as vitamin B_3. This vitamin is normally synthesized in the body in limited amounts from the amino acid tryptophan. Protein intake, therefore, contributes to the body's niacin content.

Pellagra is characterised by the three Ds; dermatitis (inflammatory condition of the skin), diarrhoea {due to inflammation of the gastrointestinal tract} and dementia {loss of memory and general mental disturbance}. The end result is often death. People suffering from pellagra usually appear poorly nourished. They are often rather weak and underweight.

Pellagra is considered a disease of the past in many countries of the world even in those where it was once a major public health problem. In most countries pellagra is associated with ration diets in refugee camps and prisons, alcohol abuse, voluntary dietary restrictions, use of anti-tuberculosis drugs and, in rare cases, in-born error of metabolism.

However, studies have indicated that pellagra is still common among poor rural people living on subsistence farming especially where maize is the staple diet. Although studies have shown that maize contain more nicotinic acid than some other cereal foods, but it has been found that the nicotinic acid in maize is in bound form from which the vitamin is nutritionally unavailable to the body.

Interventions against pellagra are directed towards treatment of the disease by supplementing those affected by medicinal preparations of niacin derivative. Other B-complex vitamins are normally prescribed as well.

Preventive measures include dietary diversification to include foods which are rich in niacin such as groundnuts and those rich in tryptophan as eggs, milk, beef, liver, kidney, poultry and fish. In general, prevention of pellagra requires a change in economic and social conditions that cause it. And, where the level of development and resources allow, programmes for food enrichment with the vitamin should be carried out.

PROPOSED APPROACH FOR BUILDING AN EFFECTIVE QUALITY ASSURANCE AND CONTROL SYSTEM IN IODINE DEFICIENCY DISORDERS CONTROL PROGRAMMES BY SALT IODIZATION

By
Tiisekwa, B., PhD and Sibiya, T. E., PhD
Department of Home Economics,
Faculty of Agriculture,
Luyendo Campus,
University of Swaziland,
P.O. Box Luyengo,
M205 Swaziland.

Abstract

The suggested approach focuses on the development of an effective quality assurance and control (QAC) system for salt iodization (SI) programmes within the environment of the East, Central and Southern Africa (ECSA) region. The suggestion is based on reports from the ECSA region and a review of relevant literature on SI and QAC.

The poor performance of some ongoing salt iodization and Iodine Deficiency Disorders (IDD) control programmes within the Southern Africa region (SAR) has been attributed largely to some deficiencies in the present practices of the programmes' QAC system. In the proposed approach, the meanings of quality and quality assurance are emphasized against which a practical QAC system is developed.

In the proposed approach two levels of structure, namely, the salt iodization QAC management committee (QACMC) and the salt iodization programme team are suggested. QACMC will identify and coordinate the activities of the programme team composed of all key players in the salt production, distribution and consumption channel.

Introduction

Iodine deficiency is a serious widespread micronutrient problem throughout the world (Hatzel, 1993). People who are deficient in iodine may suffer health disorders ranging from goitre to a more serious irreversible mental, intellectual and physical retardation (Dunn and Van der Haar, 1990). The elimination of IDD among population is a world wide concern (Annon, 1990; Buscaglia, 1994; Kavishe, 1993a b; Tiisekwa and Sibiya, 1994; Todd, 1993; UNICEF, 1985).

Different programmes for elimination of IDD in the ECSA region are in place and have achieved various degrees of success (Dunn and Van der Haar, 1990; Hahn, 1994; ICCIDD, 1992; Kavishe, 1993a) and more programmes are planned to address the problem (Tiisekwa and Ngwenya, 1996) with the view of eliminating IDD by the year 2000. According to Dunn and Van der Haar (1990) and Kavishe (1993b), iodized salt has been widely adopted as a means of correcting iodine deficiency.

A number of reports focusing on IDD have been compiled based on national, regional as well as international meetings (Buscaglia, 1994; Dunn and Van der Haar, 1990; ICCIDD, 1992). Varied aspects on salt iodization including progress, constraints, components and criteria are covered. One of the major problems which is apparent from these reports and though to be limiting factor for the success of the IDD control programmes is lack of or inadequately worked out QAC system. An effective QAC system is an essential component for elimination of IDD in the ECSA region by year 2000.

According to ILSI (1994) an effective QAC system must be simple, practical, cost effective and sustainable. A properly worked out QAC system will structure the system organization, assign responsibilities to key players and identify means of control and evaluation.s

Therefore, with the view to contribute to the global efforts for successful control of IDD through salt iodation, this paper proposes an approach by suggesting considerations in the form of steps which could be used in the ECSA countries. The experiences drawn from the countries within Southern Africa have used to fit within the principles for quality assurance and control. The proposed methodology is based on principles which also could be applied to other micronutrients such as vitamin A and iron deficiency control programmes.

Methodology

Based on reports on programmes being pursued within the ECSA region, it is apparent that in some cases the organization of quality assurance function has been confused with that of quality control. The experiences of countries which are implementing salt iodation for IDD control programmes have been particularly useful in identifying the successes and limitations of their set up. The collected information form the basis for building an organizational structure which must be pilot tested before being applied in a particular situation. It is expected that through the list of activities in the programmes dealing with IDD problems answers to questions like what is being done, who is doing what, who and what is available, cost, problems and possible solutions will become apparent and be used in the management plans to identify the necessary components for an effective programme.

Therefore, the approach to the development of an effective QAC system should be based on a clear understanding of the meanings of quality, assurance and quality control, their functions and organization. An analysis of the components of these functions would lead to the identification and selection of the necessary components for achieving the quality function in the entire IDD programme. The relative quality costs then can be judged from appraisal of the QAC system.

The Meaning of Quality

According to Paranthaman (1989) quality carries different meanings to different people. It is defined by a characteristic. In this proposal, an IDD programme quality is defined on two distinct meanings of quality; the quality of design and the quality of conformance. Under IDD programme we are dealing with the quality of the product (iodized salt) and quality of the delivery of the salt (e.g. timeliness). On one end of the delivery chain we have a producer and the other end, the consumer. The producer and consumer must have good understanding on the product or service quality in order to ensure business/programme success and sustainability. The whole idea of quality can be represented by the scheme in Figure 1.

The producer agrees with consumer or requirements or specifications. The product, process or service is designed according to requirement. The manufacturer transforms the design or plan into quality products or services which is then tested to appraise the quality of conformance. If it fails the test, it is re-designed until when it meets the consumer requirements. In this way quality is continuously built into the product or service, thus leading to sustainability. It is necessary and possible using scheme to identify who are the key players, where they fit, and the critical control points.

Based on the scheme in Fig. 1, it is apparent that several people or institutions are involved between production and consumption involving a number of functions which are performed to ensure that there is conformity to the quality of design. A recent report by Buscaglia (1994) observed that every country had its unique pattern of salt production, distribution and consumption. This was clearly apparent also from a report by Kavishe (1993a) while commenting on programmes in selected African countries.

However, based on an analysis of salt production and distribution systems, Buscaglia concluded that a common pattern is indicated for different developing countries and that the same occurs with the implementation of salt iodization. Salt iodization programmes in some of the reporting countries have performed with varying degrees of success (Swaziland National Nutrition Council/UNICEF (1994). Fig 2 depicts a simplified channel of salt movement. In order to

identify the key players who have an influence on salt, its quality and movement, it is necessary to conduct a survey of active programmes in a given country and gain experiences which can be used to prepare a checklist of issues to be addressed.

The unique features of programmes and experiences in each country have been observed by Buscaglia (1994). The observed unique features would be of value for the development of an effective QAC. In these countries, three situations are represented: (1) a programme based on all imported salt (2) part of salt (some iodized) locally produced and part imported (3) all salt locally produced. Examples of key players identified in the salt movement include, the politician, Nutrition Council, International support (UNICEF), Coordinator of IDD programme, transporters of all types of salt, food legislators, laboratories and community workers.

Through consultations with all key players, it will be possible to identify the required practical salt standards and consumption quality, timely delivery and also to learn the attitudes of consumers. All the identified key players would contribute the programme team. Based on the above considerations a situation leading and description of programme components, critical control points and associated weakness will be achieved.

The Meaning, Operation of QAC System and Fulfilment of Function

QAC system is an effective method of attaining and maintaining the desired quality standards. Based on the fact that quality is the responsibility of all functions (everybody in the programme) the interrelated functions can be broken down into component subsystems depending on situation as follows:

- Management of quality system and planning, organising, integrating and measuring.,
- Product quality and reliability development - address characteristic in design, market requirements and consumer needs.,
- Product and process quality planning-methods and procedures.,
- Supplies quality assurance-control of supplier quality, responsibility, rating and surveillance.,
- Product and process quality evaluation and control - ensuring performance to specification - in process - final audit and controls.,
- Special quality studies - investigational analytical, statistical?.,
- Quality information and feeback - advising management on quality - decision making corrective action.,
- Quality measuring equipment/criteria - assured accuracy.,
- Quality training and manpower development - developing capability of people - qualifications, training, etc., and
- Product performance feedback-field performance - corrective action - product improvement.

Within these subsystems, the two most important principles of quality operate i.e. the principle of prevention and the principle of coordination. the Quality assurance system is an evaluation or audit of each of these sub-systems to determine how effectively the functions are being performed. The QAC feedback scheme presented in Fig. 3 illustrates how auditing can be achieved.

Based on the above sub-systems, the various identified key players can be assigned responsibilities to pursue. Where they don't exist, they should be created to take care of a particular responsibility. Two basic responsibilities of total quality control function are to provide QAC for the products and to assist in ensuring optimum quality costs for them. These responsibilities can be fulfilled through the illustrated three sub-functions in Fig. 3.

Proposed Six Steps for Implementation of the QAC System

The building of an organization structure of an effective QAC system will define the components and state the responsibility and accountability of every party involved. It is built based on the following six steps:

1. Define quality problem of IDD - quality of iodized salt, timeliness, etc.,

2. Establish objectives that IDD programme must achieve, shot and long term.,

3. Determine the basic work elements that must be accomplished in meeting the programme objectives - clarify the basic work elements into appropriate number of 3 basic functions, i.e. planning, measuring and analysing as in Fig. 3.,

4. Combine these basic functions into responsibility packages each of which should have the following characteristics - should be logical and indicate field of application.

   They should be clear-cut and definite with respect to scope, purpose, objectives and results to be obtained. Only single man/ office should be held responsible for any one function; They should have authority along with responsibility for every position; there should be easy workable relationships among the various positions in the programme.,

5. Consolidate responsibility packages into programme component or components suitable for the requirements., and

6. Locate the components in that segment of the large organization where it can do its job and achieve its objectives with maximum effectiveness and minimum friction and establish relationship with other organizational components that are necessary to realize the objectives.

Proposed Implementation Structures for the Proposed QAC System

According to country reports for Angola, Botswana, Lesotho, Mozambique, Namibia, South Africa and Swaziland, different levels of achievement have been achieved with respect to key considerations which are viewed as part of the components for effective IDD programmes. According to Swaziland National Council (1994), at least three countries out of seven did not have or accomplished the following aspects:

1. IDD survey/assessment.,
2. Study salt import/export.,
3. Monitoring system.,
4. Legislation.,
5. Inter-Ministerial collaboration.,
6. Advocacy campaign., and
7. Information, education and communication

However, all countries had a responsible institution, a Ministry, Development or Nutrition Council/Unit, and except for South Africa, all obtained UNICEF support. Based on the above observations the following structures are proposed:

Structure 1.

There is need to have a responsible institution which should identify the key players and perform a coordination function of the three sub-functions as represented in Fig. 3. The institution should be an appropriate one concerned with the health/ wellbeing of the people. In some countries, it has been Ministerial departments specially created for some specified tasks which may include IDD problem. We propose that whatever the institution selected, it should be concerned with health and should be reporting to the highest government office. According to the Swaziland Nutrition Council/ UNICEF (1994) report, the Minister of Health had remarked, ***"Salt iodization is already taking place. The technology is neither sophisticated nor unusually expensive. The number of supplies are few. Salt is sold by retail businessmen. Why then, can't we simply ban non-iodized salt for human and animal consumption? I can not understand why we make a declaration (such as the conference*** **on** ***IDD in 1986 in Cameroon, the 1990 World***

Summit for Children, the Hidden Hunger Conference in 1991 in Montreal, the ICN in 1992 in Rome among others) and then do nothing about it! What is the problem? We hope that this report will help governments, programme managers, and others concerned with IDD begin to pinpoint their own problems and help them develop and implement appropriate strategies and interventions."

In order to function effectively, the coordination institute should form a salt iodation QAC management (SIQACMC) committee. The team which should be chaired by a person from the institution should be limited to nine members with representatives from various sectors of key players such as the manufacturers association or forum, consumers, retailers, quality control laboratories, legislators, politicians, transporters (distributors), the press, etc.

Structure 2.

Formation of the salt iodation programme team. This should be composed of all key players identified by the SIQACMC. The committee will have a duty to perform social marketing and advocacy to sensitize all key players on all issues of IDD and the salt iodation programme. Among the indirect key players would be researchers who might be requested to collate information and collect data on such issues as stability of iodine in the form used and under existing conditions of storage, transportation and all forms of handling. Alternatively, some sub-committee could be formed from the programme team to address specific sub-functions outlined area and report to the SIQACMC.

Conclusion

The proposed QAC approach for an effective salt iodation for IDD control suggests a multisectoral participation and calls for committed participation of players for effectiveness.

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Figure 1. The meaning of quality

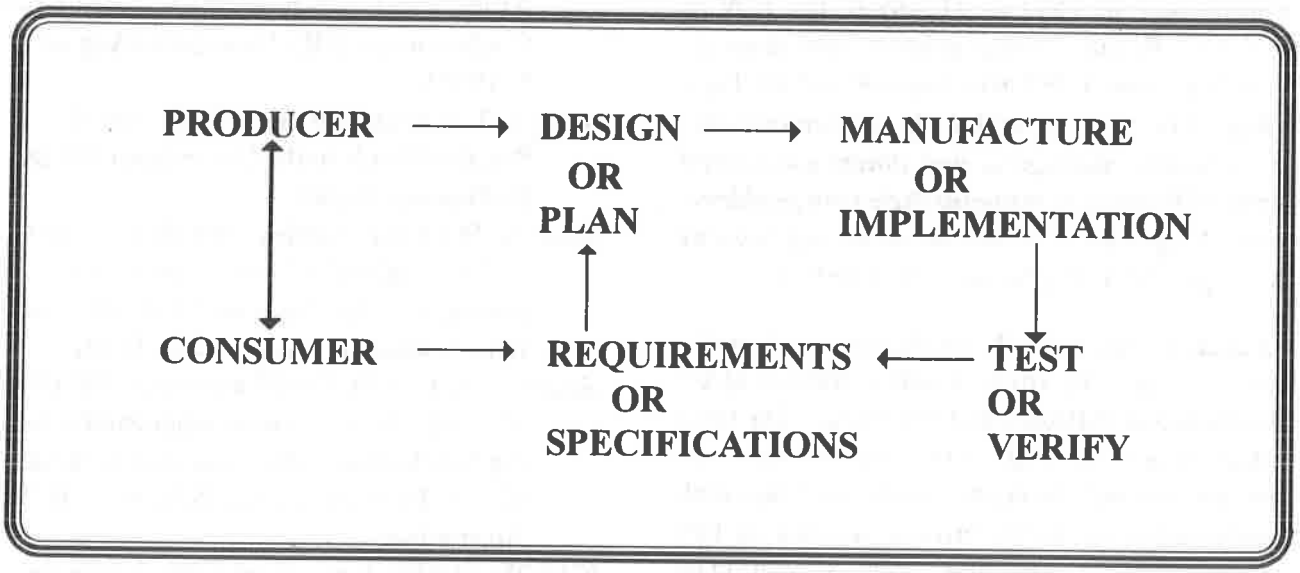


Figure 2. QAC link with salt supply channel

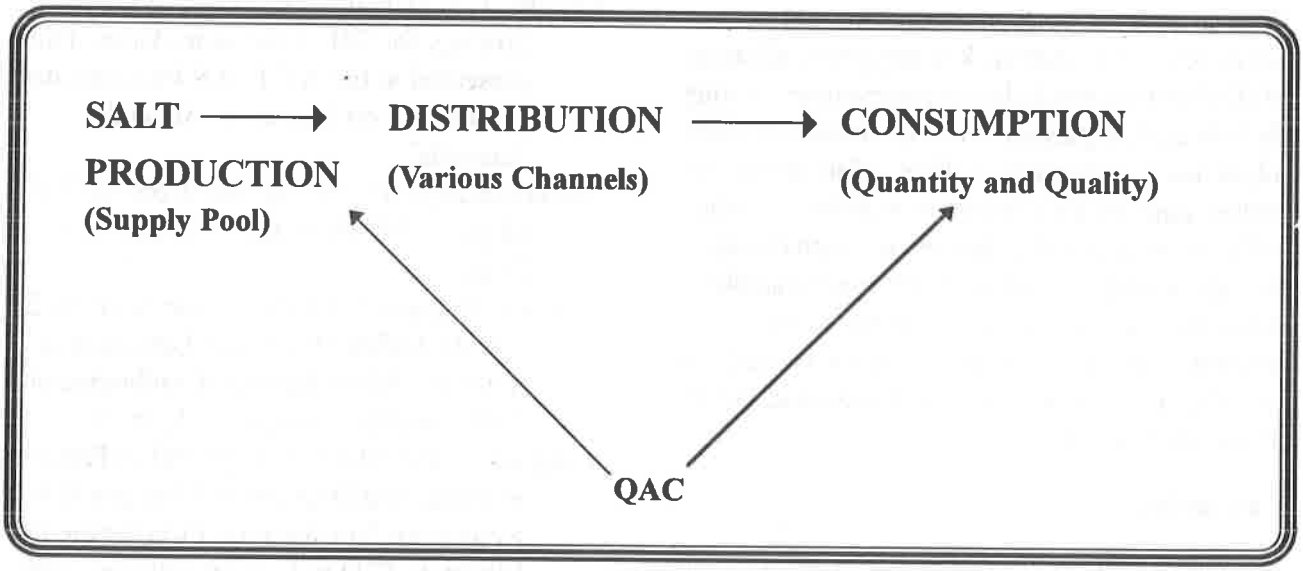
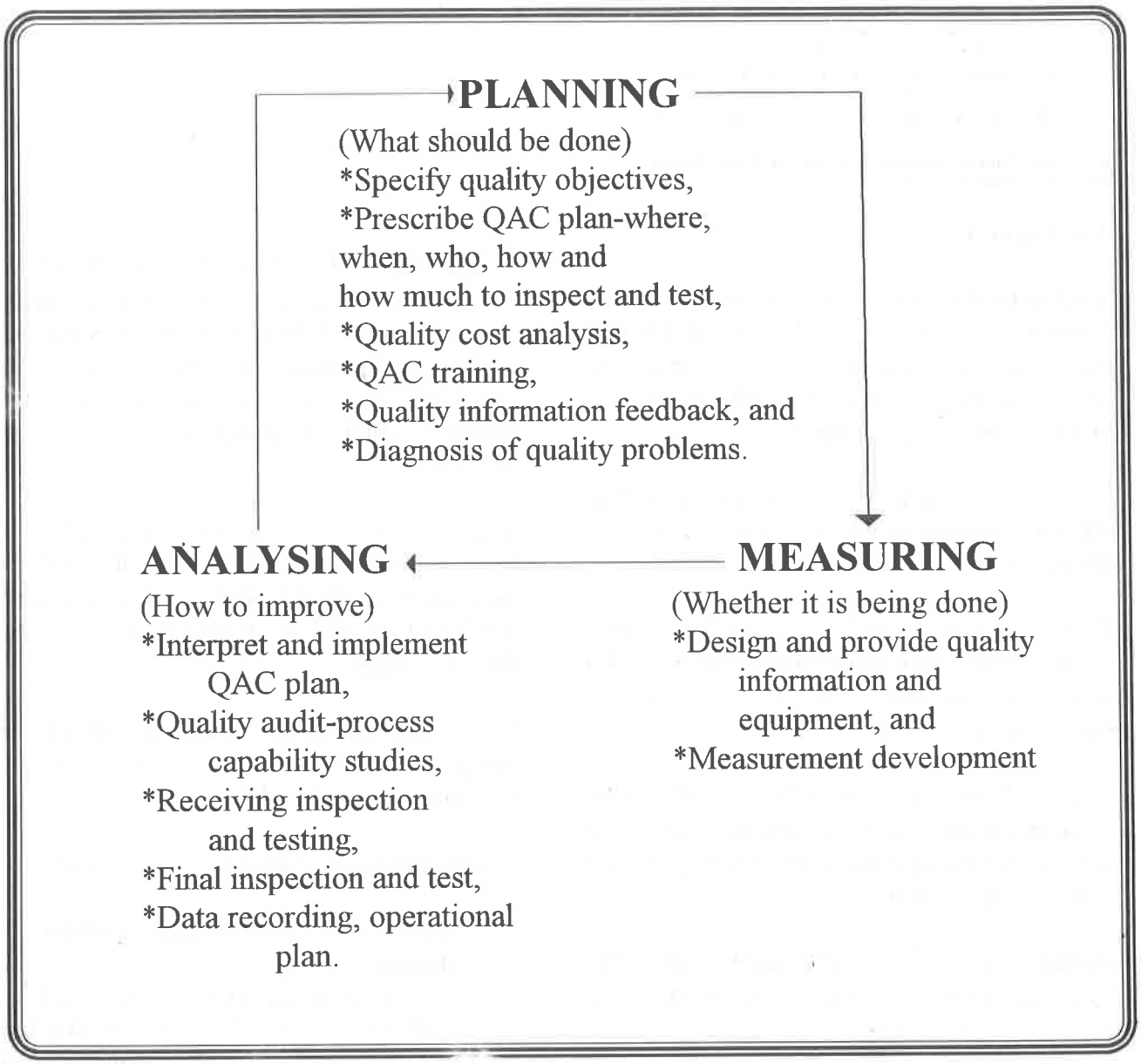


Figure 3. Feedback mechanism in QAC



PELLAGRA PREVALENCE AND RISK FACTORS IN IRINGA RURAL DISTRICT, TANZANIA

P. Francesconi [1], P. J. Luvanda [2], B S. Kibiki[3], v Pisani[1]
1. (Medical Officer, CUAMM College for Health Cooperation, Iringa)
2. (Dermato-Venerology Officer Iringa Regional Hospital)
(Health Officer, Iringa District Coordinator for IDD Control)

Key words: Nutritional Disorders, Pellagra, Public Health.

ABSTRACT

A population based, cross-sectional survey was conducted in 1996 among adults living in Iringa Rural district, Tanzania, to determine the prevalence of Pellagra and assess the importance of some putative risk factors.

An overall prevalence of 27.5 percent was found. The disease seems to appear in July-October and disappear in December-February.

It affects women and men equally, is more common in people without formal education and in alcohol consumers, especially in those who use whole maize flour.

Quality of housing (as an indicator of the socio-economic status), kind of crops harvested, food taboos and use of hormonal contraceptive are not corrected with it.

Pellagra is a public health problem in Iringa Rural district mainly related to alcohol use, and action needs to be taken.

However, further research is needed to investigate actual association with alimentary habits and develop appropriate health strategies.

INTRODUCTION

Iringa Rural district is one of the six districts of Iringa region, Southern highlands of Tanzania. It is inhabited by an estimated population of 427,121 people (1995) living in 182 villages and spread over an area of 28,457 km_2. Most of the district's inhabitants are peasants whose diet is based on maize, is short of some essential nutrients and is affected by alcohol intake. In such a setting, pellagra, a multiple vitamin-deficiency disease, is expected to be endemic *(1,2,3,4)*.

Most of the staff working in the 67 Peripheral Health Units of the district report that actually, during August to February, many adults manifest signs and symptoms such as dermatosis, gastro-intestinal disorders, stomatitis, and mood changes, which are commonly diagnosed as pellagra. *(5,6)*.

However, because the disease is officially reported as unspecified "nutritional disorder" and no research on the subject has ever been done in the district, little is known about it and many even deny its existence.

For this reason a cross-sectional survey was designed in order *to determine prevalence of pellagra among the adults.*

At the same time an attempt was made to:

1. determine the seasonal pattern of the disease;
2. investigate the association between pellagra and some putative risk factors, such as kind of crops harvested other than maize, mode of flour preparation, alcohol intake, food taboos, and use of oestrogenic contraceptives and
3. Assess people's knowledge on the causes of pellagra.

Materials and Methods

The population based, cross-sectional study was conducted during the 2nd and 3rd weeks of October, when the pellagra prevalence is supposed to be at its peak.

All people over 14 years of age, living in Iringa Rural district were included in the study. Assuming a prevalence and a tolerated error of

15percent and no difference in the pattern of prevalence from one cluster to another, a sample of 56 clusters, each of 12 people to be selected through the "EPI method", was drawn with probability of inclusion proportional to size. Each clinician was then assigned at least one village but this adjustment did not change either the proportion of villages furnished with health facilities or the number of villages per each sub-district division.

Data were collected through structured interviews (see questionnaire translated into Kiswahili in Annex 1) by the 50 clinicians working in the District government Peripheral Health Units (PHUs), who were previously trained during a one-day work-shop.

The assessment of pellagra was done through clinical examination, using the following strict case definition: "presence of symmetric skin lesions (pigmented, rough, cracked, scaly skin) localized over forearms" *(6)*.

Ten randomly selected field works were supervised by one of the main researchers.

All the field workers but one interviewed the required 12 adults for a total of 6599 interviewees. The response rate was 62.4percent The survey was anonymous and an explanation of the purpose of the study was given to the interviewees before obtaining their consent. All interviewees were given relevant health education and those with pellagra were treated with a full course of multivitamins.

The collected data were entered and analysed in EPI-INFO.

Results

Respondents' Characteristics

- 415 interviewees (63.4%) were females and 240 (36.6%) males. The age group frequencies are given in Table 1.
- 343 (53%) had completed the 7-years circle of primary education and only 6 (0.9%) attended secondary school; the rest (47%) had no formal education at all.
- 621 (94.2%) defined themselves as farmers, 19 (2.9%) unemployed, 15 (2.3% dealers and 4 (0.6%) civil servants.
- 506 (76.9%) live in thatched houses, while 152 (23.1%) in iron roofed ones.

Prevalence and Seasonal Pattern of Pellagra

- 181 cases of pellagra were detected out of the 658 examined, which brings the overall prevalence to 27.5 percent (95% CI = 23.5-31.5%)

The prevalence of pellagra per age-group is shown in Table 1, together with age-group frequencies.

Table 1: Case of pellagra and age-group frequencies

AGE GROUP	No. OF EXAMINE	% OF TOTAL EXAMINED	PELLAGRA CASES	PREVALENCE
15 - 19	62	9.4	4	6.4%
20 - 29	172	26.1	23	13.4%
30 - 39	151	22.9	40	26.5%
40 - 49	134	20.3	52	38.8%
50 - 59	70	10.6	26	37.1
60 - 69	45	6.8	22	32.0%
> 70	14	2.1	9	6.4%
N.A	11	1.8	5	45.4
TOTAL	659	100	181	27.5%

Almost all the affected people reported that their symptoms, usually, appear in July-October and disappear in December-February (Chart 1).

Knowledge on Pellagra

541 respondents (82.1%) had knowledge of the disease. Out of these, 367 (67.6%) related it to malnutrition but failed to be more specific. Poor hygiene of the body, mosquitos and exposure to sun were also reported as causes.

Risk Factors

- All respondents harvested maize. In addition, 484 (73.7%) harvested another crop, most frequently beans (260, 53.7%), sunflowers (81, 16.7%), groundnuts (54, 11%), potatoes (44, 9%, peas (25, 5.1%) and other legumes (20, 3.4%).

- 505 respondents (76.6%) reported to be usual alcohol consumers with no difference between males and females (74.2 and 77.8% respectively). Out of those, 204 (40.3%) declared to consume one litre or less of local beer (*pombe*) per day, 271 (53.6%)2 to 3 litres and 29 (5.7%) 4 or more.

- 134 respondents (20.3%) reported consuming whole-meal maize (*dona*), 75 (11.4%) dehulled (*sembe*) and 450 (68.3%) dehulled and washed (*kivelege*).

- 252 respondents (38.2%) reported to have some forbidden foods, most often antelope, wild birds, rats.

- Out of the 415 female respondents, 46 (11%) stated to use hormonal contraceptives. The majority (35, 76%) use pills, 11 (24%) injections.

Associations

- The prevalence is the same in men (27.5%) and in women (27.8%) but increase with age with a plateau for people at their forties and fifties, 40 percent of whom are affected (Chart 2 and Table 1).

- People without formal education are more likely to be affected than people with formal education (Table 2, P = 0.00). The correlation persists after stratifying for age (p = 0.01).

Tab 2: Respondents' education and pellagra

	AFFECTED	NOT AFFECTED	TOTAL
People without Formar Education	120 (38.7%)	180	31
People with Formal Education	61 (17.5%)	287	348

- People who consume alcohol are more affected than people who do not (p = 0.00, Table 3). The correlation persists after stratifying for age (p = 0.01)

Table 3: Respondents' habits about alcohol and pellagra

	AFFECTED	NOT AFFECTED	TOTAL
Alcohol Consumers	169 (33.5%)	336	505
Not Alcohol Consumers	12 (7.8%)	141	153

- Strong alcohol consumers are more likely to be affected than moderate ones ((P = 0.00, tab 4).

Tab 4: Amount of local beer consumed per day and pellagra

	AFFECTED	NOT AFFECTED	TOTAL
1 Liter or Less	47 (23%)	157	204
More than 1 Liter	122 (40.5%)	179	301

- The disease is more frequent in people who prefer to use whole maize flour than in those using refined one (P = 0.00, tab 5). The correlation persists after stratification for age and is stronger in alcohol consumers.

Tab 5: Kind of flour consumed and pellagra

	AFFECTED	NOT AFFECTED	TOTAL
Whole Flour Users	53 (39.6%)	81	134
Refined Flour Users	128 (24.4%)	396	524

The type of the house the interviewees live in (as an indicator of their purchasing power), is not correlated with the disease prevalence, neither is the reported use of contraceptives.

Similarly, there is no significant difference in pellagra prevalence between people who reported to harvest only maize and people who harvested also some kind of legumes nor between respondents who have some food taboos and those who have not.

DISCUSSION

An overall prevalence of pellagra of 27.5 percent among adults living in Iringa Rural district was found.

The low response rate and the difficult differential diagnosis in old people may have biased the

results, however, the existence of pellagra as a local public health problem has been clearly demonstrated.

This was the main objective of the survey which was designed primarily for that purpose. The additional data, therefore, should be interpreted with caution.

According to the interviewees, pellagra seems to be present from August to February (Chart 1), when large amount of local beer (pombe) is available. However, no evidence has been gathered to confirm this seasonal pattern.

The age pattern (Chart 2) is the expected one with a plateau in the 40-60 years old *(1,2)*. The peaks showed in the oldest age groups might have been biased by over-diagnosis done in presence of senile xerosis.

Education seems to be a protective factor while living in iron houses, which is supposed to reflect a higher purchasing power, is not. But the choice of only one indicator as approximation for social status may have not been adequate.

Unexpectedly, *(1,2,3,4,5,6)* no association was found between pellagra and having harvested legumes, while using whole flour seems even a risk factor, especially in alcohol consumers.

However, these data were collected by simple interview, and somehow, may have been biased. Furthermore, no objective check of the answers on risk factors was included in the survey.

Further research is needed to investigate actual correlation between diet and pellagra, in order to provide people with effective health education.

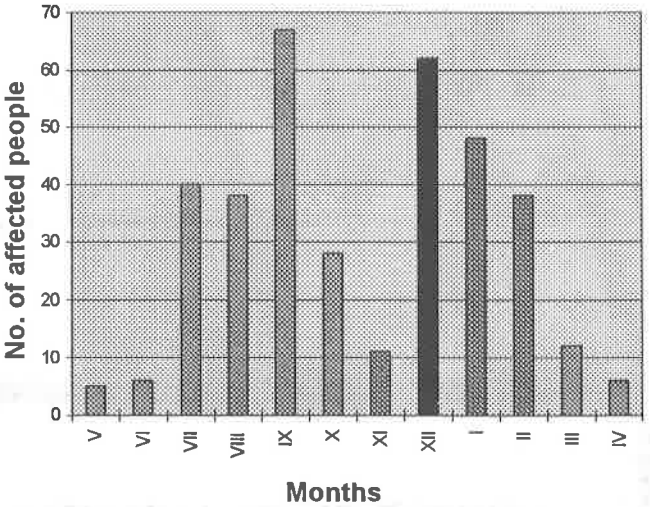
However, as expected *(7,8)*, alcohol consumption is the most important risk factor. Also the quantity of alcohol assumed per day seems correlated with the disease. Indeed it reduces both food intake and tryptophan conversion to niacin.

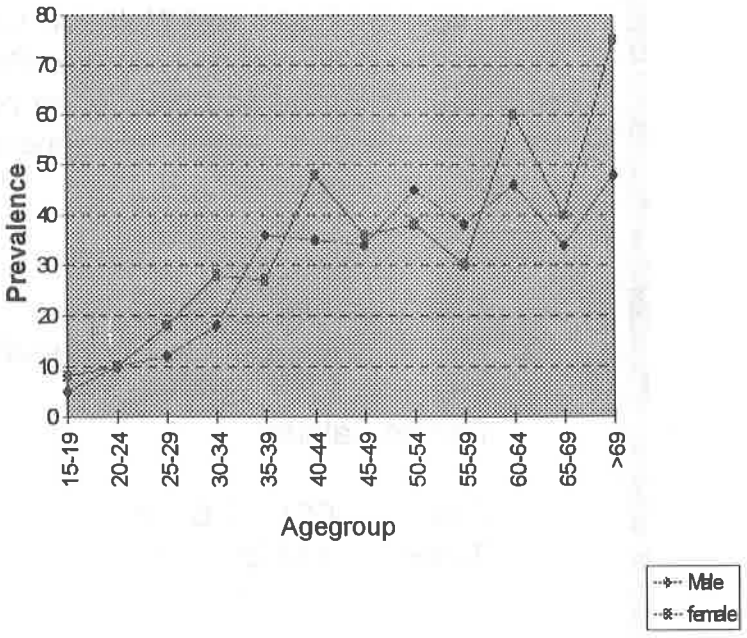
The reported food taboos are not likely to affect substantially respondents' diet.

The suggestion that administered estrogens could be an additional factor in the development of pellagra *(9)* has not been confirmed by this research.

- In conclusion, we think pellagra exists in Iringa Rural (and probably in other similar districts in Tanzania). Tens of thousands of adults are probably affected by a severe disease which is entirely preventable: this does call for action.

Chart 2: Prevalence by age and sex





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MATERNAL MORTALITY AND MORBIDITY IN DEVELOPING COUNTRIES - A REVIEW

J. J. Mbunda,
Tanzania Food and Nutrition Centre

Abstract.

The level of maternal mortality remains high in most of the developing countries. The World Health Organisation (WHO) estimates that about 500,000 women die each year from complication of pregnancy, abortion attempts and child birth. Maternal mortality in Sub-Saharan countries is 686 death per 100,000 births whereas 444 per 100,000 births is recorded in Asia and 162 deaths per 100,000 birth in Latin America.

The immediate causes of maternal mortality are pregnancy and pregnancy related complications such as haemorrhage, infection, pregnancy induced hypertension, obstructed labour and uterus rupture. Poor health status, reproductive status and inaccessibility to health services are among the underlying causes. Socioeconomic factors such as illiteracy, poor economic status and cultural inhibition with regard to legal position in decision making process among women are observed to be basic causes perpetuating the risk of maternal mortality. However, preventive actions such as maternal health education, family planning and integrated commitments to all social and economic development sectors, are the ultimate solutions for reducing this tragedy.

Key words: Maternal, Mortality, Maternal education and Family planning.

Introduction

This paper explores the magnitude, causes and preventive measures with regard to maternal mortality in developing countries basing on the review of various maternal mortality study reports. In recent years, various intervention programmes with regard to Safe Motherhood have been promoted globally. To mention a few, these include family planning, prenatal care, nutrition supplementation and tetanus immunization. Despite these efforts, developing countries still remain with the highest maternal mortality levels.

Levels of maternal morbidity and mortality

Maternal mortality constitutes one of the major health problems in most developing countries. The World Health Organisation (WHO) estimates that about 500,000 women in Developing Countries die each year from complications of pregnancy, abortion attempts and childbirth. The discrepancy between maternal mortality rates in developing countries and those in developed world is greater than any other demographic indicators; for instance the number of maternal death among women of reproductive age in Bangladesh and India is about 100 times the number in the United States (Mc Carthy and Mainel, 1992).

The present estimated maternal mortality ratios for a variety of Developing Countries over the period between 1983-1991 show a considerable difference among countries whereby Sub-Saharan Africa is leading by having higher ratio of 686 deaths per 100,000 births. Others are Southern Asia 444 deaths per 100,000 births and Latin America and Carribean 162 death per 100,000 births.

However, within these countries there is a big difference on maternal mortality between urban and rural areas. A recent study conducted in Southern India showed that maternal mortality ratio was 798 deaths per 100,000 births whereas in rural areas the ratio stood at 830 deaths per 100,000 births higher compared to a ratio of 545 deaths per 100,000 births in urban areas (Bhatia 1993).

Estimates of maternal mortality in most developing countries are based on hospital statistics and small segments of population, therefore, they portray a situation which is

relatively far from the truth. Registration system for vital statistics is not well established and updated as a result reported maternal deaths constitute only a fraction (Bhatia, 1993). Induced abortion in most countries is illegal and traditionally discussion on abortion is treated as clandestine (Coeytaux, 1988). These circumstances result into difficulties in getting information on abortion related death cases. Hospital statistics usually do not reflect socioeconomic pattern of the community and therefore, it becomes difficult to design intervention. Community or population based studies have been applied to collect information but due to their low coverage, it has been difficult to get national estimates. However, in recent years Demographic and Health Surveys in most developing countries managed to obtain national estimates, despite the fact that its sustainability depends massively on external support.

Causes of maternal mortality

According to the International Classification of Diseases (ICD) cited by Bhatia (1993), maternal death is defined as death of a woman while pregnant or within two days of termination of pregnancy or by the pregnancy or its management but not from accidental or incidental causes. From this definition, a woman must be pregnant and experience some complications of pregnancy or child birth or have a preexisting health problem that is aggravated by pregnancy, before her death can be defined as maternal death. This series of events is most directly influenced by three levels of causes; immediate, intermediate and distant causes.

Immediate causes

At immediate level of causes we have those factors which their ultimate outcome is maternal disabilities and death, these include; pregnancy and pregnancy related complications. Complications here refer to those with direct contribution to death eg. haemorrhage, infection, pregnancy induced hypertension, obstructed labour and ruptured uterus. In Egypt, a big number of women are suffering from at least one gynaecological or related morbidity whereas the prevalence of Reproductive Tract Infection (RTI) among women of reproductive age is 51%. It is argued that the increased risk of reproductive tract infection is aggravated by a combined vaginal and uterine prolapse which is caused by exposure of genital organs to an unclear external environment, pelvic congestion and ulceration and interference of blood supply (Kane et al, 1992).

Intermediate causes

Health status of a woman, reproductive status, accessibility to health services and health care behaviour or use of health .services are among the intermediate causes of maternal mortality.

Maternal malnutrition limits productive capacity and make reproductive role to be unsafe and sometimes leading to the death of both mother and new born (Kavishe, 1993). Infection and parasitic diseases such as malaria, hepatitis, tubeculosis etc. are among the leading preexisting health conditions that are worsened by pregnancy and delivery and they account for approximately one quarter of maternal deaths in developing countries (Maine et al, 1992).

Malaria is dangerous for pregnant women because it decreases natural immunological defence during the last months of pregnancy. There is a relationship between maternal mortality and some reproductive characteristics (age, parity and pregnancy order, etc.) in that there is high risk of maternal death for very young women, old women and women with no previous birth experience while there is low risk for women in between.

In a study of maternal mortality conducted in Egypt, 38% of observed maternal deaths were among women who were over the age of 35 years and 24% for women who had had seven or more births (Kane et al, 1992). Omran and Stanley as cited by Mac Carthy (1992) argued that polarity can influence one of the major disabilities that result from pregnancy, uterine prolapse which is much more common among high parity women. Unwanted pregnancy also is among the contributing important factors to the increasing risk of maternal morbidity and mortality, particularly to a women seeking an abortion. In

Bangladesh, the National Research Council in its recent study on maternal mortality suggested that 18% of maternal mortality might be due to post abortion complication (Montgomery and Lloyd, 1994).

In most developing countries there is low coverage of formal health services particularly in rural areas (FAO/WHO, 1992). However, shortages of facilities such as blood transfusion, antibiotics and other drugs aggravate the risk of maternal mortality. Several studies reveal that maternal mortality is lower in areas with advantages of health services while it is higher in disadvantaged areas (Wasserheit et al 1989; Younis et al 1993; and Bhatia 1993). In Southern India 40.9% of maternal deaths occurred at home and about 8.5% happened while the women were on the their way to the hospitals (Bhatia, 1993). The use of prenatal care and the use of care during and after delivery are particularly important as far as the maternal mortality is concerned.

In a recent anthropological study on younger mothers' use of traditional birth attendants *(Daya)* and health care system during pregnancy and delivery in low income neighbourhood conducted in Egypt, it was revealed that, generally women viewed giving birth as a process that does not require prenatal health care (Kane et al, 1992). Similarly, in the same study it was found that women valued modern health services for their capabilities in curative medicine rather than in preventive purpose. As a result among women who died without receiving prenatal care were those whose family members reported that they were not sick or prenatal care was not necessary.

Distant causes

Socioeconomic and cultural factors at individual, family or community level are the basic causes of perpetuating a risk of maternal mortality. In most circumstances and for most diseases including maternal mortality, the poor and disadvantaged are more likely to die than more affluent people (Mc Carthy, 1992). Similarly, the differential in maternal mortality by socioeconomic status may exist among countries (developed and developing) and within countries (rural and urban).

In a community study on gynaecological and related morbidities in rural Egypt conducted in 1989 it was found that the vast majority of women who have suffered from at least one gynaecological or related mobidity were uneducated and of low socioeconomic status. In Brazil, 65% of those women who became mothers before the age of 20 years came from families with low socioeconomic status contrast to 48% to women who delayed childbearing (World Bank, 1993). In rural areas, it is difficult to meet day to day socioeconomic needs. The only alternative of having adequate labour force is to have more children, a situation which puts women at high risk of maternal mortality due to frequent pregnancies.

Illiteracy among women, initiation practices during puberty and general traditional preparations to women on wife to be which, in some tribes circumcision practice is incorporated, are meant to psychologically subjugate women to the level of sex subjects for men. The perpetuation of these practices maintain customary inferior status of women in a family or community with regard to socioeconomic decisions.

Cultural inhibitions which affect the legal position of women with regard to decision making also increase that risk of maternal mortality given the fact that sometimes women might be aware of their risk circumstances. Women in West Africa know about pregnancy and delivery, the preparation they should make, the complications that can occur and what they should do about life threatening complications but the decision to take necessary are all determined by complex interaction of social and cultural factors that vary both between families and communities. In most communities, people believe that the will of God, heredity and evil spirits can cause obstetric complications. In such situations, the care of traditional healers and diviners is sought first and the modern health-care system is used only as a last resort.

Initiatives to reduce maternal mortality

Experience has shown that effective medical treatment of complication of pregnancy and

delivery is essential if maternal mortality is to be substantially reduced, but in many developing countries there are shortages of medical facilities, well trained personnel, supplies and equipment because of resources constraints in the central government. A relative decline of maternal mortality levels in the past decade though still high comparing to developed countries, to a great extent is due to the massive financial and material support from International organizations and donor countries.

In Tanzania for instance, trends in maternal mortality indicates a substantial decline from about 450 deaths per 100,000 births in 1961 to about 215 deaths per 100,000 births in 1991. This success cannot be explained without mentioning UNICEF, WHO, SIDA support, etc. The sustainability of the success is in doldrums due to external dependence.

Family Planning Programme is one of the global initiative to reduce the maternal deaths. The program me which started in early 1950s and implemented seriously since 1960s currently covers almost all Third world countries. The success of the program varies from one region to another due to the varying degree of political and leadership commitment, and availability of contraceptives. The experience shows that regional socioeconomic progress has been simultaneous with the progress of family planning program me. This is reflected by the fact that regions or countries with relatively higher income per capital (GNP), good transport communication network and adequate health facilities, have higher rates of contraceptive use and hence low mortality. In East Asia nearly two third of married women use contraceptives. Similarly, in China, Hong Kong and Singapore more than 70% of married women are using contraceptives whereas Middle East and South Asia is 25%. Sub-Saharan Africa has 10% of women who are using contraceptives among the married women, the lowest in world (World Bank, 1993).

In recent years there have been some initiatives of intergrating to the family planning program me a component of development which a community identifies as a priority, so that the programme can use it as an entry point to the community and, therefore increase programme acceptance (Integration of land management with family planning in Indonesia, Integrated Family Planning Nutrition and Parasite Control Programme in Tanzania and Zambia). In Tanzania, Kimanjaro region which is under the Integrated Family Planning, Nutrition and Parasite Control Programme has 33.1% of women currently using contraception, the highest percentage in the country (Ngalaba, Set al, 1992).

The quality of family planning services matters in all phases of programme development. In the early stages services are new and contraception still lacks social legitimacy. Once the programme is well established and accessible, quality counts because the cost of family planning such as physical side-effect can limit further success. In a study conducted in Bangladesh it was found that intra uterine device (IUD) users and tubectomised women were approximately four times likely as to have abnormality discharge or lower abdominal pain compared to non-users (Weisserheit et al 1989). Provision of good periodical counselling to clients is important because women contraceptives need change in the reproductive life cycle.

In many studies the question of illiteracy among women has been observed as a barrier to the use of health services and women to disentangle from low status. Long term improvements in formal education particular for girls will help to bring about a decline in maternal mortality.

However, in short term maternal health education should be encouraged for pregnant mothers when they attend clinic. Provision of maternal health education to the village Primary Health Care (PHC) Committee which constitutes influential people, Extension Workers and Traditional Birth Attendants (TBAs) will enhance community to initiate their own means through locally available resources to reduce maternal mortality (eg. making follow-up to pregnant women who are not attending clinic regularly, emergency preparedness, etc.).

A sustained effort to mobilise the will and resources necessary for high quality of health services system, maternal health education and community to disentangle from negative attitudes toward modern health facilities is the challenge to be undertaken by the developing countries themselves. Assistance from International organisations and donor countries should be taken as a catalyst on their on going initiative rather than depending wholly on developed countries.

Most of the developing countries have adequate resources to effective social services to their people, health being one of them. The best solution is to remove laxity among the government institutions such as Tax and Revenue departments to enhance government collection of financial resources. In its article 'Donors freeze aid over Tanzania tax fraud claims' newspaper ***The Times*** of 25th November, 1994 reported that 60% of all foreign aid to Tanzania has been frozen after allegation that imports worth millions of pounds have been lost to smuggling sanctioned at the highest levels of government. The paper continued by quoting Mr. Thomas Palme, Swedish ambassador to Tanzania who said, "...Swedish taxpayers cannot substitute for Tanzania taxpayers, they can only supplement them. Tanzanians themselves must make effort to pay ...".

Economies in the third world countries are characterised by excessive foreign debt and trade deficits, negative economic growth, excessive public debt and inefficient use of available resources. Foreign debt, as percentage of Gross National Product (GNP), increased from 23% in 1981 to 42% in 1987 among all developing countries, Sub Saharan Africa countries having higher percentages (85%). World Bank under its fashionable programme Structural Adjustment Programme (SAP) is supporting third world countries to rectify those above mentioned problems with the condition that budget in social sectors should be cut.

In countries like Tanzania and Zambia, public sectors have been playing a big role to the socioeconomic well being of their people since independence, therefore, it is true that with the implementation of SAP, social sectors including health will be adversely affected though, there are arguments that with proper implementation of SAP, long term social and economic development attainment is viable.

Conclusion

The levels of maternal mortality remain high in many of the developing countries comparing with that developed countries inspite of the declining trends for the past two decades. Low coverage of health services and quality deterioration on the existing one due to inadequate equipment, supplies, medical personnel, etc. are among the aggravating poor situations on maternal morbidity and mortality. Similarly, the persistent strong negative traditional attitude towards use of modern medical preventive services in the rural community and women illiteracy are still the basic barriers to the improvement of maternal health. The essence of the Primary Health Care is that community participates in and organise the essential elements of their own health care with the support of the nearest health centre. The extent of community awareness of health issues and their capacity to develop health intervention programmes at the community level is an important determinant for improving health services utilisation and hence reducing maternal deaths.

Generally, the causes of maternal mortality emanate from poverty, therefore, integrated commitment to all social and economic development sectors are the ultimate solution to this tragedy.

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POLYPHENOL CONTENT IN VARIOUS LEGUMES AND CEREALS AS DETERMINED BY THE PRUSSIAN BLUE TEST METHOD

[1]Towo, E. E. and[2]Svanberg U.

[1]Tanzania Food and Nutrition Centre, Dar es Salaam, Tanzania
and
[2]Department of Food Science, Chalmers University of Technology, Goteborg, Sweden

Abstract

Polyphenols were determined in sorghum-udo, cowpeas, pigeon peas, green grams, kidney beans and bambara nuts. They were classified into total phenols, tannin-type phenols (condensed tannins) and non-tannin phenols by using the Prussian Blue Test method. The method was tested for its reproducibility before its application. The poly phenol content were either expressed as catechin equivalents (C.E.) or tannic acid equivalents (T.A.E.).

The Prussian Blue Test method was shown to be reproducible with a coefficient of variation ranging from 4.4 to 6.8%. The method also produced standard curves with a correlation coefficiant of 0.998 for tannic acid and 0.997 for catechin. The phenolic content in different food grains was variable. The total phenolic compounds in different food grains ranged from 0.24 to 0.85 gram catechin equivalent (C.E) per 100 gram dry sample, while the tannins and non-tannin phenols ranged from 0.09 to 0.52 and 0.15 to 0.33 C.E per 100 gram, respectively. The values were significantly ($P<0.05$) lower when expressed as tannic acid equivalents compared with catechin equivalents. The capability of the Prussian Blue Test method in analysing and classifying phenolic compounds in food materials and the nutrition consequences of these grains as food are discussed.

Key words: Phenolic compounds, tannin, tannin acid, catechin.

Introduction

Polyphenols such as tannins are widely distributed in plant kingdom. These phenolic compounds are secondary metabolites which play a defensive role in the plant by protecting them against herbivores, insects, birds and bacterial/fungal spoilage. However, their antinutritional and physiological effects to humans and animals have been recognized for a long time. Numerous reports are available on the influence of commercial tannin acids and/or other dietary phenolic compounds on the growth rate, energy value, mineral metabolism, protein and amino acids both in vitro and in laboratory animals. Alzueta et al. (1992) observed a significant decrease in protein digestibility as a result of including faba beans in the diet.

Siegenberg et al. (1991) showed that by adding 12 mg tannic acid into a meal decreased iron absorption in human by one third and 50 mg tannic acid reduced absorption by almost 70%. Similar results were earlier reported by Brune et al. (1989) and the inhibitory effect was related to the galloyl group of tannic acid. Svanberg et al. (1993) indicated poor availability of *in vitro* iron from high-tannin cereals as compared to low-tannin cereals. Griffiths and Moseley (1980) measured a lower intestinal trypsin and a-amylyse activity in rats fed with high-tannin faba beans than those fed with low-tannin faba-beans.

Carrera et al. (1973) showed a lower utilization of vitamin B 12 in rats fed tannic acid while Suschetet (1975) measured a lower level of vitamin A in the liver of rats given 3.5% tannic acid in the diet. Studies done by Singleton and Kratzer (1969 and 1973) have shown that the ingestion of high concentration of tannin from diets can cause gastroenteritis and congestion of intestinal walls. Morton (1970) showed some correlation between plant tannin consumption and oesophageal cancer while Kapadia et al. (1976) revealed a possible carcinogenicity effect of tannin compounds on rats when administered

subcutaneously. Phenolic compounds like tannins can, therefore, possess both antinutritional effects as well as physiological effects to human and animal subjects when consumed in large amount from plants.

Various methods are available for polyphenol determination in food materials. These include, the Vanillin assay method (Burns, 1971), the Prussian Blue Test method (Price and Butler, 1977), protein precipitation assay (Haegeman and Butler, 1978) and the Folin-Denis assay methods (Burns, 1963). The Prussian Blue Test method, which is colorimetric, produces changes of colour which can be easily be distinguished visually and thus gave it a credit for its applicability in the field routine work. It is among the simple methods which can be used to classify phenolic compounds into total phenols, tannin type phenols (condensed) and non tannin phenols.

The objective of this study was to analyse different Tanzanian food grains for their phenolic content. The phenolic compounds will be classified into total phenols, tannin-type phenols (condensed tannins) and non-tannin phenols.

Materials and Methods

General Procedure of the Prussian Blue Test Method

A suitable aliquot (usually 6 to 10 ml in case of food extracts) is raised to 50 ml with distilled water. To this, 3 ml of 0.1M ferric chloride dissolved in 0.1N HCL is added, followed by the timed addition of 3 ml of 0.008M potassium ferrcyanide reagent. The optical density is read at 720 nm after 10 minites.

Analysis of Phenols or Tannins in Food Materials

The Prussian Blue Test method (Price and Butler, 1977) was used to determine the amount of phenolic compounds in food materials. Food grains, brown sorghum (udo variety), cow peas, pigeon peas, kidney beans, green grams and bambara nuts, were purchased from a local market in Tanzania. The dried grains were milled into flour using a disc-type mill (Laboratory Mill 3300) and kept at room temperature in air tight plastic container before being analysed for phenolic content. A weighed sample of about 60mg of the ground food (flour) was taken and 5ml of the extraction solvent (water/salt solution) was added and mixed by shaking vigorously using a laboratory shaker for one minute. The mixture was centrifuged for minutes at 5,800 r.p.m. and the extract was collected. The sediment in the test tube was rinsed with another 5ml of the solvent and the extraction procedure was repeated. The pooled clear solution was raised to 50ml by distilled water in a volumetric flask and the Prussian blue reagents were added. Optical density (absorption) was measured at 720mm after 10 minutes. The results were calculated and expressed both as gram catechin equivalent (C.E.) per 100g sample and as gram tannic acid equivalent (T.A.E.) per 100g sample.

Reproducibility of the Prussian Blue Test Method

Several determination were repeatedly at specific concentration for each phenolic compound; tannic acid at 0.125 mg/ml, catechin at 0.25 mg/ml and sorghum-udo extracts. A sample of 60 mg of sorgum-udo flour was extracted in 10ml of distilled water to obtain the sorghum-udo phenolic extracts. The coefficient of variations were calculated statistically for each.

Statistical Analysis

A descriptive statistical model of "Microsoft Excel Computer System" was used to calculate the mean values, standard deviation and standard error of replicate samples. The reproducibility of the Prussian Blue method was related to the coefficient of variation (CV) obtained by the following equation:

$$\textit{Coefficient of variation (CV)} = \frac{\textit{Standard deviation (sd)} \times 100\%}{\textit{Mean}}$$

Linear regression analysis and Pearson correlation models were used to study the correlation between polyphenol concentration and absorbance readings.

Results and Discussion

Phenolic Content in Different Food Materials as Determined by the Prussian Blue Test Method

Total phenols, tannins and non-tannin phenol content in different food grains are shown in Table 1 and in Figure 1 as gram catechin equivalents/ 100 gram sample. In Table 2 the values are shown as gram tannic acid equivalents/100 gram sample. The values are significantly higher ($p<0.05$) when expressed as catechin equivalents compared to tannic acid equivalents. It can be observed that sorghum-udo and cowpeas contained significantly ($p<0.001$) more total polyphenols (0.85 and 0.58g C.E./100g sample respectively) than the other grains and the bambara nuts had the lowest value (0.24g C.E./100g sample). A similar pattern was observed on tannin content.

Sorghum-udo, which is a cereal grain, had higher proportion of tannin (61%) than non-tannin phenols while the proportion of tannins and non-tannin phenols are more or less equal in the legume food grains. While the total phenols and tannins are significantly higher ($p<0.001$) in sorghum-udo compared to cowpeas, the amount of non-tannin phenols content are almost equal in the two grains. The amount of polyhenol content in green grams, pigeon peas and kidney beans do not differ significantly from each other.

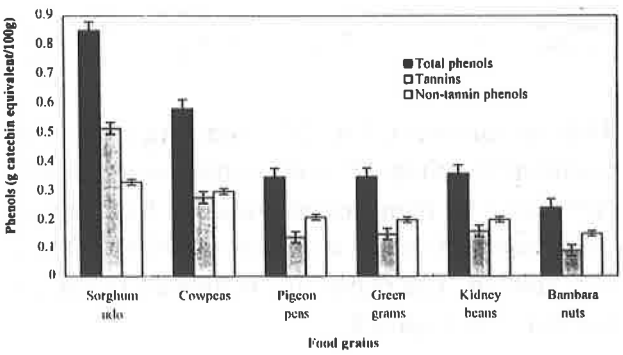
Sorghum varieties are known to contain significant amount of phenolic compounds such as tannins. Price and Butler (1977) indicated a value of 0.58g catechin equivalent per 100g in a high-tannin type sorghum (Br-54 variety) using the Prussian Blue method with water extraction. With the same method, Earp et al. (1981) determined the polyphenol content in eight varieties of brown sorghum (high-tannin types) ranging from 0.24 to 0.99g C.E./100g. By using the modified Vanillin-HCL method, the range was 0.36 to 3.48g C.E. respectively on the same samples. The Vanillin assay method has been shown to over-estimate phenolic content in food materials (Price and Butler, 1977).

Table 1: Polyphenol content (mean sd) in six Tanzanian food grains (g catechin equivalents/100g of sample).

Type of Grain	Total phenols	Tannins	Non-tannin phenols
Sorghum-udo	0.85 ± 0.06^{a}	0.52 ± 0.05^{b}	0.33 ± 0.02^{c}
Cowpeas	0.58 ± 0.05^{b}	0.28 ± 0.04^{d}	0.30 ± 0.01^{c}
Pigeon peas	0.35 ± 0.02^{c}	0.14 ± 0.01^{e}	0.21 ± 0.02^{de}
Green grams	0.35 ± 0.02^{c}	0.15 ± 0.01^{e}	0.20 ± 0.01^{de}
Kidney beans	0.36 ± 0.01^{c}	0.16 ± 0.01^{e}	0.20 ± 0.01^{de}
Bambara nuts	0.24 ± 0.02^{d}	0.09 ± 0.02^{e}	0.15 ± 0.01^{e}

Values having different letters (a-e) are significantly different ($p < 0.001$)

Figure 1. Phenolic content in various Tanzanian food grains expressed as gram catechin equivalent/100 gram sample).



The error bars indicate the average standard deviation.

Table 2. Polyphenol content (mean sd) in six Tanzanian food grains (100g Tannic Acid Equivalents/100g of Sample).

Type of Grain	Total phenols	Tannins	Non-tannin phenols
Sorghum-udo	0.73 ± 0.05^{a}	0.44 ± 0.05^{b}	0.26 ± 0.04^{cd}
Cowpeas	0.50 ± 0.04^{b}	0.26 ± 0.04^{cd}	0.24 ± 0.04^{d}
Pigeon peas	0.30 ± 0.01^{e}	0.12 ± 0.01^{e}	0.18 ± 0.02^{de}
Green grams	0.30 ± 0.01^{e}	0.13 ± 0.01^{e}	0.17 ± 0.01^{e}
Kidney beans	0.31 ± 0.01^{e}	0.14 ± 0.01^{e}	0.17 ± 0.01^{e}
Bambara nuts	0.21 ± 0.02^{d}	0.08 ± 0.01^{e}	0.13 ± 0.01^{e}

Values having different letters (a-e) are significantly ,different ($p < 0.001$

Reproducibility of the Prussian Blue Test Method

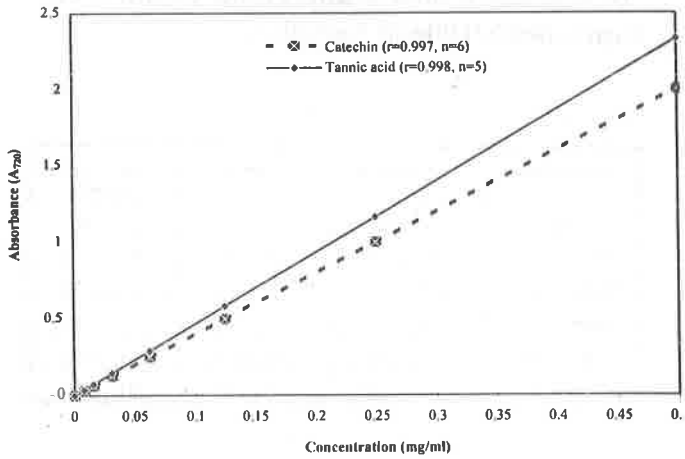
Two commercial phenolic compounds and sorghum-udo phenol extracts were used to test the reproducibility of the Prussian Blue Test method (Table 3). The coefficient of variation obtained were 4.9% for tannic acid and 6.8% sorghum-udo. The slightly higher coefficient of variation obtained for sorghum-udo phenol extracts compared to commercial phenols is likely to be explained by the extraction procedure.

Table 3. Reproducibility of the Prussian Blue Test Method, Absorbance at 720 mm (A_{720}).

	TANNIC ACID (0.125mg/ml	CATECHIN (0.25mg/ml)	SORGHUM-UDO 60mg/10ml
N	33	42	20
Mean (A720)	0.826	1.066	1.985
Conf.Level (95%)	0.014	0.014	0.059
Standard error	0.007	0.007	0.030
Standard deviation	0.041	0.047	0.135
Coeff. of variation	4.9%	4.4%	6.8%

The absorbance (A720) readings for the commercial phenolic compounds were highly correlated to their concentrations. Correlation coefficients of tannic acid was 0.998 and 0.997 for catechin. The respective standard curves are presented in Figure 2.

Figure 2. Standard Curves for Tannic Acid and Catechin.



Nutritional Consequences and Conclusion

Levels between 0.2 and 2% of condensed tannins in the diet have been suggested by several investigators to cause depressed growth on experimental animals (Schaffert et al., 1974; Deshpande et al., 1984; Salunkhe et al., 1990), and this effect is mainly due to an impaired digestion of protein and carbohydrates (Lorri and Svanberg, 1993). High-tannin food products have also been reported to have a low iron availability (Radhakrishnan and Sivaprasad, 1980; Brune et al., 1989; Salunkhe et al., 1990; Siegenberg et al., 1991; Svanberg et al., 1993). A study conducted by Brune et al. (1989) indicated a marked decrease in the absorption of iron from a meal as a result of tannic acid addition in a range of 5 to 50 mg per meal and similar results were reported by Siegenberg et al. (1991). The observed phenolic content in the analysed grains with a range of 0.24 - 0.85% C.E. total phenols and 0.09 - 0.52% C.E. tannin type phenols may, therefore, impair iron absorption in human body and hence contribute to the disorders such as nutritional anaemia. Consumption of these diets which are mainly based on these grains might contribute significantly to the low bioavailability of iron in such meals and, therefore, may contribute to the problem of nutritional anaemia in the country. This calls for post-harvest treatment for such food grains which may reduce the amount of phenolic content to a significant lower level.

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