Quality Control in Foods

CARL M.F. MBOFUNG
Department of Food Science and Nutrition, ENSAI, University of Ngaoundere, P.O. BOX 686, Ngaoundere
Email: cmbofung@yahoo.com

ABSTRACT

Of recent the issue of the quality of food and its safety has been of major global concern not only in relationship to human health but also as a controlling factor in food trade within and without national boundaries. It is in this respect that international organisations such as the FAO, the WHO as well as governments , food production companies, NGOs and researchers have been paying a lot of attention on the quantitative and qualitative aspects of locally produced and imported food items. For developing countries , the problem of food quality is a contributing factor to general food insecurity often characterized by frequent food shortage. It was long believed that increasing the production of food could be the solution. Genetically modified (GM) foods were thus announced as the miracle that will enhance food availability. However, subsequent and ongoing research point to some potential negative quality and safety aspects of GM foods. GM foods so far on the market have passed risk assessment tests. Despite this, effective and efficient quality control measures are necessary, to ensure their safe and wide use. The present paper reviews the food quality problem with emphasis on the need for the setting up of a proper food quality system in Cameroon that will take care of ensuring the quality of its locally produced and imported foods . In order to set up such a system, developing countries like Cameroon will have to overcome existing inadequacies in such areas as equipment, infrastructure, trained manpower and general organisation. Towards the same objective, there is an urgent need for the funding of appropriate food and nutrition research activities to constantly serve as a backup source of information necessary for the enactment of quality control legislation and food trade activities within and without the country.

Keywords: Food quality, safety, GMO, control system, Nutrition

RESUME

Ces dernières années la question de la qualité et de la sécurité des aliments a constitué une préoccupation mondiale non seulement à cause des implications sur la santé mais aussi parce qu'elles sont un moyen de contrôle des échanges des produits alimentaires aussi bien à l'intérieur des frontières nationales qu'à l'extérieur. A cet effet, les organisations internationales comme la FAO et l'OMS, les gouvernements, les industries alimentaires, les ONG et les chercheurs ont accordé la plus grande attention aux questions relatives la qualité nutritionnelle des aliments localement produits. Pour les pays en voie de développement comme le Cameroun, le problème pose par la qualité des aliments est un aspect important de l'insécurité alimentaire le plus souvent caractérisée par des déficits alimentaires. On a longtemps cru que l'augmentation de la production serait la solution. Les OGM ont ainsi été considérés comme une solution miracle qui accroîtrait la production. Cependant, des recherches subséquentes et actuelles ont révélé quelques aspects négatifs potentiels sur la qualité et la sécurité des OGM. Par conséquent des mesures efficaces et efficientes de contrôle de la qualité des aliments sont nécessaires pour en assurer une saine et large consommation. Les aliments GM maintenant au marché ont passé les tests d'évaluation de risques. Le présent article est une brève revue des implications de la qualité des aliments avec une emphase sur la nécessité de la mise sur pied d'un système de contrôle qualité au Cameroun pour les aliments traditionnels et les OGM. Dans le but de mettre sur pied un tel système, les pays en voie de développement comme le Cameroun devraient surmonter les difficultés comme l'inadéquation des équipements, des infrastructures, les ressources humaines et l'organisation générale. Dans le même optique, il y a un besoin urgent de mener des recherches appropriés dans le domaine des sciences des aliments et de la nutrition pour appuyer la mise en place des législation sur le contrôle qualité et aussi pour fournir des informations utile dans le commerce nationale et international des denrées alimentaires.

Mots clés : Qualité des aliments, sécurité, OGM, Système de Contrôle, Nutrition

INTRODUCTION

The concept of quality has over the years been given different definitions. According to Kramer and Twigg (1962), quality is the composite of those characteristics that exist for different individual units of a product and determine the degree of acceptance of these units by the consumer. Blanchfied (1981) calls it "a multi-component measure of the extent to which the units of a product, which a seller is willing and able to offer at a price, consistently meet the requirements and expectations of the group of buyers willing and able to buy that product at that price. With particular reference to food, the term quality refers to those attributes of the food which make it acceptable to the person who eats it. In its broadest sense, this includes such positive factors of colour, flavour, texture and nutritional value as well as the negative characteristics of freedom from harmful micro-organisms and undesirable substances, whether added deliberately or present adventitiously.

Given the above definitions, food quality maybe defined as its aptitude to safely nourish the consumer, thus satisfying him fully. In this respect the definition of food quality is multidimensional and takes into account such aspects of quality as the hygienic, nutritional and organoleptic properties of food.

The hygienic quality of food is generally considered in terms of the risks that consumers face in consuming food containing toxic substances. Such toxic substances might be chemical (heavy metals, nitrates) or microbial (pathogens, toxins) in origin or could be part of the food item. Very often, it is of external origin and contaminates the food by different ways:

a. By accumulation (heavy metals, pesticides),
b. Through manufacturing errors, and
c. The toxic element might also be generated in *situ* during the production process or during inappropriate storage conditions. The toxic element can also be voluntarily added to food for technological or organoleptic purposes.

The nutritional quality of food includes qualitative and quantitative aspects. While the quantitative aspect relates to the concentration of nutrients in the food - for example its energy content, the qualitative aspect is concerns the the nutritional balance of the food considered in the background of the needs of the consumer. Food is, in this respect, enriched in vitamins, Iron, Iodine.

The organoleptic quality of food is principally concerned with sensory quality aspects of a food which the consumer can adequately judge. These include, colour, size, shape, weight, texture, consistency, taste and smell, packaging etc.

It is in the light of the above and many other considerations that 'Food Quality Control' is increasingly becoming a major concern for governments and food processing and distribution companies. According to FAO (2003) Food control is defined as a mandatory regulatory activity of enforcement by national or local authorities to provide consumer protection and ensure that all foods during production, handling, storage, processing and distribution and serving are safe, wholesome and fit for human consumption; conform to safety and quality requirements; and are honestly and accurately labelled as prescribed by law. On a particular note, food control aims at enforcing food law(s) protecting the consumer against unsafe, impure and fraudulently presented food by prohibiting the sale of food not of nature, substance or quality demanded by the purchaser.

In this era of globalisation, scientific development and growing recognition and awareness of the direct link between food and human health, consumers are increasingly getting concerned about the quality and safety of the food they eat. It is for this reason that the practice of food quality control generally aims at ensuring that food offered for human consumption not only conforms to national requirements to ensure the health of its citizens but also to meet the safety and the quality specification of food products entering international trade. In fact, the new global environment for food trade places considerable obligations on both importing and exporting countries to strengthen food control practices and to implement and enforce risk-based food control strategies. From a practical perspective these countries are increasingly being called upon to pay particular attention to those factors that contribute to potential hazards in foods (FAO, 2003) such as:

- improper agricultural practices,
- poor hygiene at all stages of the food chain,
- lack of preventive controls in food process-

ing and preparation operations,
- misuse of chemicals,
- contaminated raw materials, ingredients and water, and
- Inadequate or improper storage etc.

In addition to this, they are faced with such major challenges as the :

- Increasing burden of food borne illness and new emerging food borne hazards,
- Rapidly changing technologies in food production, processing and marketing,
- Developing science-based food control systems with a focus on consumer protection,
- International food trade and need for harmonisation of food safety and quality standards,
- Changes in life styles, including rapid urbanisation, and
- Growing consumer awareness of food safety and quality issues and increasing demand for better information.

Over and above this, there is a compelling growing concern and need for a proper focus on such food safety matters as: microbiological hazards, pesticide residues, misuse of food additives, food labelling, chemical contaminants, including biological toxins and adulteration.

During the past years this list has further been extended to include genetically modified organisms (GMO) , allergens, veterinary drug residues and growth promoting hormones used in the production of animal products.

With particular reference to GMOs, there is a huge controversy that accompanies the development of GM foods and feeds around the world for different reasons. Genetic engineering techniques are used to introduce genes in plants thus creating new plants that are resistant or tolerant to given factors – e.g. *Bt* corn resistant to pest attack as illustrated in Figure 1 by Arshad C (2002). Food crops resulting from this technology are not widely accepted. Thus, while for a long time some Genetically Modified (GM) crops (mainly two traits, herbicide resistance and insect resistance) were widely adopted by American farmers because of the commercial success of these crops, surveys in european and other populations tended to show a relatively widespread reservation/opposition to GM crops and other applications of gene technology in food production on the basis of their safety.

It is important to point out here that while a number of negative effects (Table 1) have been associated with the consumption of GM foods, some critical reviews have identified weaknesses in the designs of some of the experiments leading to the various negative views on GM foods. As of now approximately 60 different genetically modified (GM) plant lines have been officially assessed and approved world-wide.

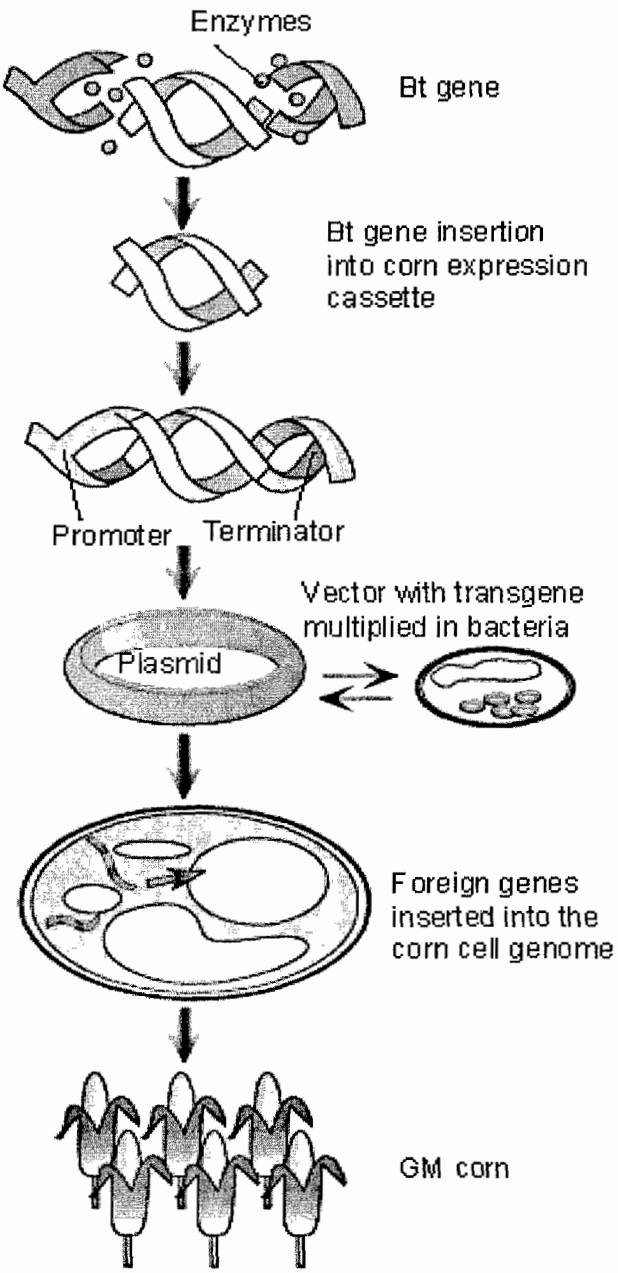

Fig. 1: General schematic of GM crop production

Table 1: Harmful effects observed in GM foods and feeds (Cummins, 1999)

Effect	Examples
1. Toxins and poisons	L-tryptophan GE killed 37 persons in 1989
2. Increased cancer risks	In 1994, rBGH injected to dairy cows yielded in IGF-1 in milk that could pose hazards for human cancer
3. Food allergies	In 1996, a Brazil nut gene spliced into soybeans induced fatal allergies
4. Damage to food quality and nutrition	In 1999, milk from cows injected with rBGH contained higher levels of pus, bacteria, fats
5. Antibiotic resistance	The Gut flora of people who eat GE food developed antibiotic resistance
6. Genetic pollution	Wind, rain, birds, bees and insect pollinators have begun carrying genetically altered pollen, polluting the DNA of non GMO
7. Damage to beneficial insects and soil fertility	Studies showed that GE crops adversely affected ladybugs and lacewings, bees and birds
8. Creation of "Super weeds" and "Super pests"	There is the emergence of the first "super weeds" resistant to herbicide-resistant crops
9. Creation of new viruses and bacteria	Viruses and Bacteria mutate into new more virulent forms
10. Genetic "Bio-Invasion"	Some GM plants or animals invade the wild species
11. Ethical hazards	Animal and Plants are reduced to the status of manufactured products

In Europe, products from ten transgenic rapeseed and maize lines have been found to comply with the Novel Foods Regulations EC 258/97. The same is true of some species of maize and soybeans. As a matter of fact, the GM foods presently available on the international market such as those presented in Table 2 have passed risk assessments tests. As of now, no negative effects on human health have been reported as a result of the consumption of such foods by the general population in the countries where they have been approved.

In developing countries to which Cameroon belongs, food systems are fragmented and dependent upon a large number of small producers. While such systems present socio-economic benefits as large quantities of food pass through a multitude of food handlers and middlemen, the safety of such foods is a public health concern because the food chain suffers from an increased risk of exposing food to unhygienic environments, contamination and adulteration especially in the urban set up where street foods are increasingly occupying a very important position in the food supply chain of an ever increasing population. Foods prepared and sold in this set up are very often limited by the lack of access to safe water, sanitary services or garbage disposal facilities. Furthermore, an increasing number of the foods sold here are produced with imported raw materials of unverified quality. The likelihood of using ingredients or foods containing undesirable GMOs cannot be ruled out.

In view of the above and especially for developing

Table 2: Some GM foods marketed on the international market

Crop	Trait	Areas/Countries with approval
Maize	Insect resistance	Argentina, Canada, South Africa, USA, EU
	Herbicide Tolerance	Argentina, Canada, USA, EU
Soybean	Herbicide Tolerance	Argentina, Canada, SA, USA, EU (for processing only)
Potatoes	Insect resistance / herbicide tolerance	Canada, USA

Table 3: Approaches taken in different countries towards GM food labelling (AFAA, 2004)

Countries	Labelling Scheme	%Threshold for Unintended GM material	Are some biotech foods and processes exempt?
Australia & New Zealand	Mandatory	1%	Yes
European Union	Mandatory	0,9%	Yes
Indonesia	Mandatory	5%	Yes
Japan	Mandatory	5%	Yes
South Korea	Mandatory	3%	Yes
Argentina	Voluntary	N/A	N/A
Canada	Voluntary standard	5%	N/A
United States	Voluntary	N/A	N/A

countries, appropriate answers need to be obtained for two but related important questions: 1) How do we go about controlling our food quality? And 2) how do we go about controlling and ensuring the safety of foods containing GMOs?

More precisely, how can a developing country like Cameroon ensure quality control of its food production and supply (at national and international levels) in this era of globalization, world trade and the development of genetically modified foods?

Compared to developed countries, food control process, in developing countries suffers from serious inadequacies from the view point of equipment, infrastructure, trained manpower and general organisation. As a consequence therefore there exists a very high and constant risk of unscrupulous businessmen exporting/importing undesirable GM foods and feeds to these countries without specific control features. The enactment and enforcement of mandatory labelling laws could be a starting point for these countries. In fact it is the case in a number of developed countries (Table 3). Cameroon has no percentage threshold but interprets "may contain" of the documents of the Conference of Parties to the Convention on Biological Diversity to mean "contains".

QUALITY CONTROL METHODOLOGY

Whether food is locally produced or imported, it needs to undergo at least three levels of quality control:

1. *Raw material control*: The control at this stage is to ensure that the raw product is clean, not polluted by microbial and chemical agents or unsafe GMOs; It should also be controlled for its nutritional quality.
2. *Process control*: The critical points in all food processes should always be carefully controlled so as to significantly reduce or completely eliminate contaminants as well as limit nutrient losses.
3. *Final product control*: Before leaving the factory, the food product must be checked for nutritional value, toxic agents and microbial pollution. Samples must be taken from each batch of raw material and finished product and properly stored for the purposes of traceability.

With particular reference to GM foods, the additional quality control measures need to be rigorously carried out with the view to evaluating the foods for their:

- direct health effects (toxicity),
- tendency to provoke allergic reactions (allergenicity),
- specific components thought to have nutritional or toxic properties,
- the stability of the inserted gene,
- nutritional effects associated with genetic modification,
- any unintended effects which could result from the gene insertion,
- safety of new proteins,
- occurrence and implication of unintended effects,
- role of new foods in diets, and
- influence on food processing.

The guiding framework on how this should be done has for a long time been the subject of several meetings and discussions involving such organisations as

the Organisation for Economic Cooperation and Development (OECD), the International Food Biotechnology Council (IFBC), the Food and Agriculture Organisation (FAO), the World Health Organisation (WHO), and the International Life Sciences Institute (ILSI). As of now, some significant degree of international consensus has been reached on the principles regarding the quality control of genetically modified foods. In particular, the concept of substantial equivalence has been developed and accepted as part of a quality and safety evaluation framework, based on the idea that existing foods can serve as the basis for comparing the properties of GM foods with their appropriate non-GM counterparts.

The application of this concept takes into consideration the fact that existing food supply, in the absence of known anti-nutrients and toxicants, is generally safe, as experienced by a long history of use. It is worthwhile pointing out here that the application of the concept is not a safety assessment per se, but helps to identify similarities and potential differences between the existing food and the new product, which is then subjected to further toxicological investigation. On the whole, the substantial equivalence is the starting point in the safety evaluation rather than an end point of the process itself.

Generally the main parameters that must be taken into consideration in the determination of the substantial equivalence of a GMO or GM food should include molecular characterisation; phenotypic characteristics as well as the presence/absence of allergens. This should be accompanied by a simultaneous characterisation of inherent toxicological risks and nutritional benefits. Thus the whole process requires an integrated, multidisciplinary approach (Figure 3), incorporating a sound knowledge of molecular biology, toxicology, nutrition and genetics. In this process, the specific issues to be addressed include: (i) evidence for nutritional/health claims and target populations; (ii) toxicological and beneficial dose ranges of selected compounds (iii) impact on overall dietary intake and associated effects on consumers; (iv) interactions between food constituents and food matrix effects; and (v) possibilities for effective post-market surveillance. While some of these assessments may make use of classical analytical techniques, newer innovative techniques such as the DNA microarray technology and proteomics are needed in order to characterise the complex interactions of bioactive food components at the molecular and cellular levels.

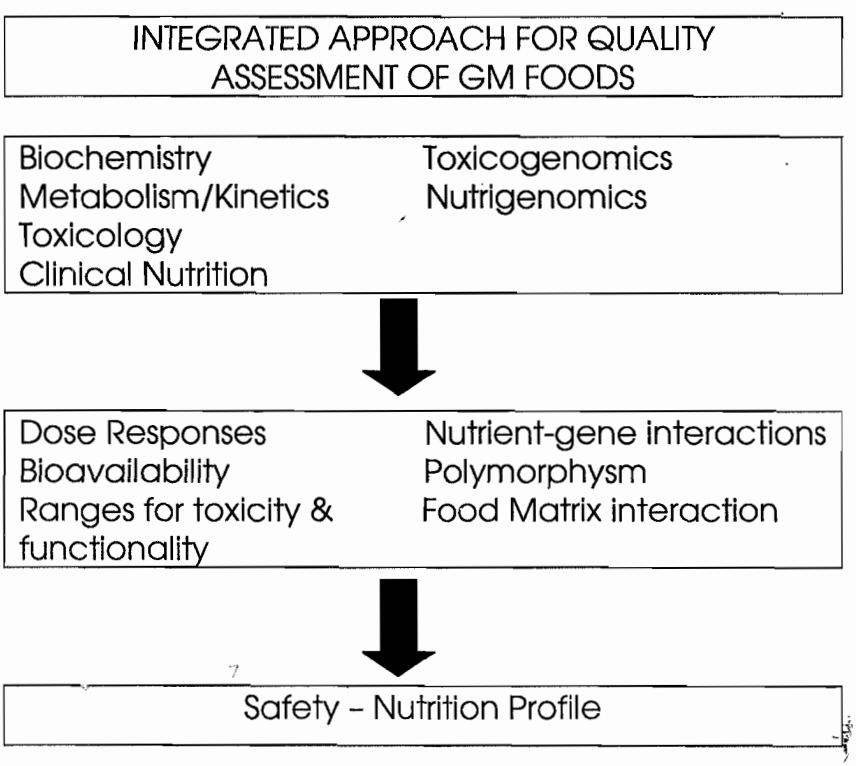

Fig. 2: Integrated approach for quality evaluation of genetically modified foods (Kuiper et al, 2001)

Usually GM food products contain an additional trait encoded by an introduced gene(s) which produces/produce additional proteins(s) that confer(s) the trait of interest. Raw material (e.g. grains) and processed products derived from GM crops might thus be identified by testing for the presence of introduced DNA or by detecting expressed novel proteins encoded by the genetic material. Available screening methods used in the process control for either the presence of the introduced DNA or that of the novel protein. A number of such methods are listed in table 4.

In the proposed quality control scheme, compositional studies aimed at determining the nutritional quality of the food is an important step. It is highly recommended that compositional studies make use of standard methods of the analysis of

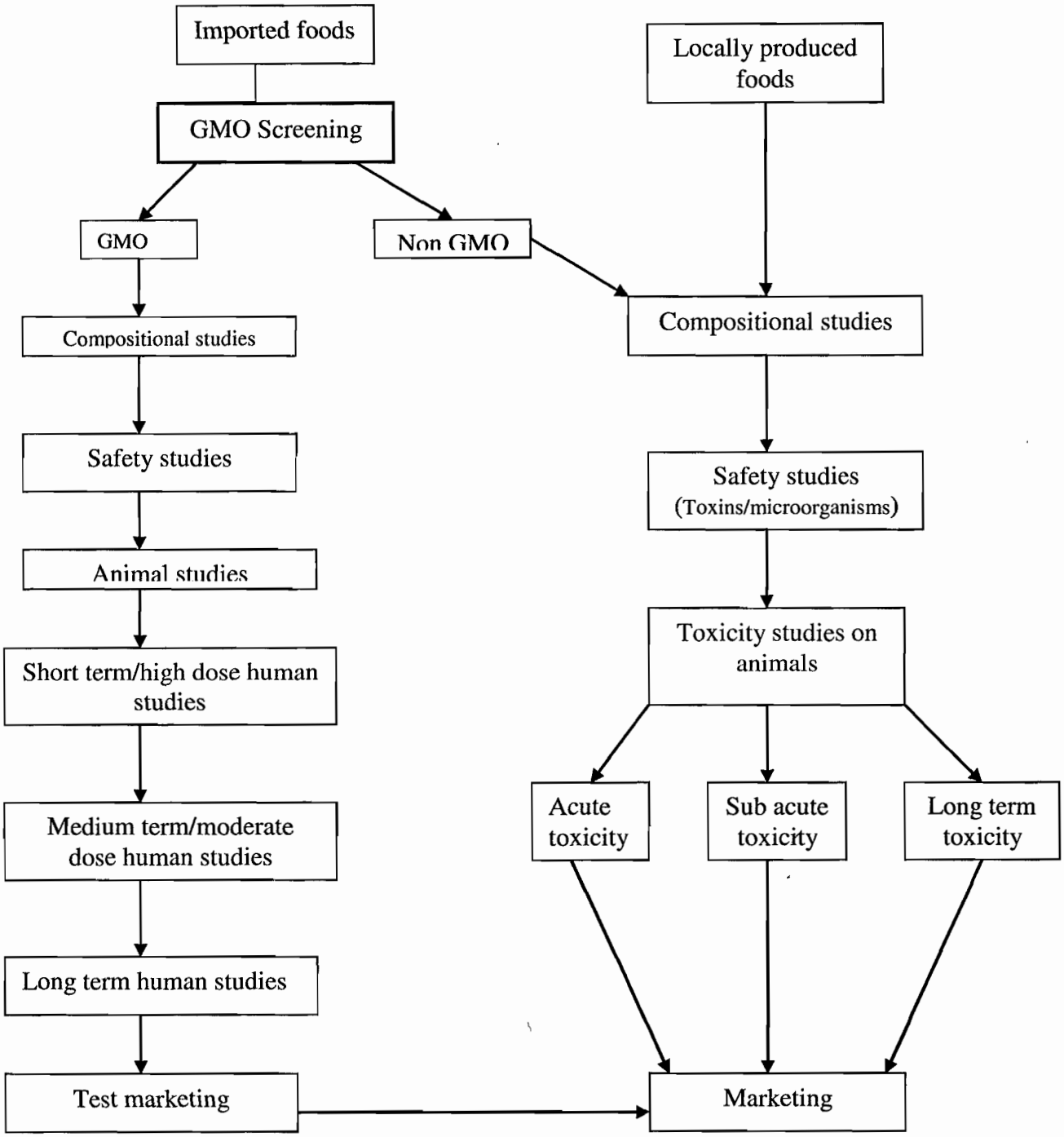

Fig. 3: Flow sheet of a proposed quality control scheme

Table 4: Some Methods of GMO testing (adapted from Finn Holm, 2002)

Method	Test for	Price (FCFA)	Time of analysis	Comments	Results
Elisa	Protein	1300-2000	2-4 hours	Easy but requires experience. Protein specific	Quantitative
Lateral flow strip	Protein	1000-3500	10-20 minutes	Easy	Qualitative
PCR	DNA	66000-210000	1-3 days	Great experience and specific equipment required	Very sensitive and specific. Quantitative
Southern blot	DNA	66000-210000	4-6 days	Great experience and specific equipment required	specific

foods. Such food constituents as carbohydrates, fats, protein, amino acids, fatty acids, minerals and vitamins should used and the results compared to standards designed by regulation. In so doing tests should seek any alterations in the nutrient between traditional non-GM foods and GM foods. Needless to mention here that this requires the use of appropriate equipment and materials by well trained manpower.

Equally important is the safety testing process. For traditional foods, the microbiological quality should be determined first. For this purpose, the total flora, and pathogens have to be evaluated by standard methods and the fitness with regulation determined prior to any decision making. Acute, sub acute and long term toxicity tests must be carried out on laboratory animals using known methods. For GM foods combined nutritional/toxicological studies will focus on the effect of feeding animals on the growth, feed conversion efficiency, anti nutrients, digestibility, biochemical and biological parameters by referenced methods.

Another yet important aspect of food control process is that of tests for allergenicity. Allergenicity studies are realised using *in vitro* tests such as immunoblotting with sera from individuals sensitised to the original crop if the gene is from a crop of known allergenicity. Assessment of allergenicity is difficult if the gene is transferred from a source not eaten before or with unknown allergenicity.

Challenges of the food Control system in Cameroon: An effective food control system is feasible only if it is well structured and equipped and run by competent staff. There is an urgent need for such a system in Cameroon. For such a system to exist the following must be realised:

1. An independent Food Control Body must be created. The duties of such an organisation will, *inter alia*, include:
   - Developing a national food safety policy and strategies,
   - Preparing food legislation, food regulations and standards and codes of hygienic practice,
   - Implementing food inspection programmes,
   - Promoting the establishment of food borne disease surveillance activities.

2. The administration must :
   - ensure that legislation on food quality is respected by a fair justice,
   - help in training the personnel of the Control body for a science-based decision making,
   - make available the required scientific resources in the international community,
   - promote methods and technologies that prevent food borne disease such as the HACCP system,
   - constantly develop or enhance the food analysis capability,
   - develop and deliver hygiene training and education programmes.

3. With particular reference to the issue of GMOs, the administration
   - must render labelling mandatory for any food item entering the national territory and particularly for GMOs,
   - enforce the capabilities of the Control Body to detect GMOs and to assess their safety and allergenicity,
   - train specialists run special sections of the Control Body charged with the analyses and detection of GMOs in foods, and
   - carry out sensitisation campaign among the population.

4. Concerning street foods
   - This activity must be organised in small controllable units in lieu of present individual producers;
   - The producers need to be trained through regular seminars on food quality and the safety of their product;
   - A structure must be created in charge of financing the acquisition of small scale production material that help in maintaining the safety and the nutritional quality of foods ;
   - Special training on the safest methods of food processing.

It is important to stress here that for any good policy decisions aimed at a food quality control system to be taken, they must be grounded on proper scientific evidence. For this reason there is urgent need in Cameroon for the setting up and running of a well organised food and nutrition research with emphasis on such aspects as:

1. Production methods and processes (including knowledge of biotechnologies) for foodstuffs and animal feeds which are safer, healthier, more nutritional, functional and varied and environmentally friendly, based on systems such as integrated production, lower input farming and organic farming;

2. The epidemiology of food-related diseases and allergies, including methods of analysis of food allergies, in particular the impact on children's health;

3. The impact on health of new and/or functional foods, food containing genetically modified organisms;
4. Traceability in the production chain, with emphasis on GMOs and similar products;
5. Methods of analysis, detection and control of chemical contaminants and existing or emerging pathogenic micro-organisms (such as viruses, bacteria, yeasts, fungi, parasites, etc);
6. The impact on human health of animal feed, in particular products containing GMOs and the use of sub-products of various origins;
7. Environmental health risks (chemical, biological and physical) linked to the food chain with particular reference to street foods.

In conclusion, research findings on the relationship between food and health is increasingly emphasising the need for the control of the quality of food sold in national and international markets. In addition, advances in biological sciences have given rise to the introduction of GM foods of debatable quality in human food chain and trade. There is a need for a systematic control of such foods for their quality and safety. Developing countries including Cameroon, have a lot to do in this respect especially with regards to food containing GMOs. Policy decisions aimed at the food system must be grounded on scientific evidence. Towards this goal, developing countries in general and Cameroon in particular, are under the obligation to set up and carry out appropriate food research activities in order to back up quality control legislation and food trade within and without the country.

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