Guidelines for the Development of a Simplified Dietary Assessment to Identify Groups at Risk for Inadequate Intake of Vitamin A

A Report of the International Vitamin A Consultative Group (IVACG)®

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The purpose of the International Vitamin A Consultative Group (IVACG) is to guide international activities aimed at reducing vitamin A deficiency in the world. The group offers consultation and guidance to various operating and donor agencies that are seeking to reduce vitamin A deficiency and its accompanying blindness. As part of this service, IVACG has prepared guidelines and recommendations for

- Assessing the regional distribution and magnitude of vitamin A deficiency
- Developing intervention strategies and methodologies to control vitamin A deficiency
- Evaluating the effectiveness of implemented programs on a continuing basis so that the evaluation of the effectiveness of intervention techniques is a continuing and dynamic procedure
- Research needed to support the assessment, intervention, and evaluation of programs

Monographs published by the International Vitamin A Consultative Group are

- *Guidelines for the Eradication of Vitamin A Deficiency and Xerophthalmia* (1977)
- *Recent Advances in the Metabolism and Function of Vitamin A and Their Relationship to Applied Nutrition* (1979)
- *The Safe Use of Vitamin A* (1980)
- *The Symptoms and Signs of Vitamin A Deficiency and Their Relationship to Applied Nutrition* (1981)
- *Biochemical Methodology for the Assessment of Vitamin A Status* (1982)
- *Reprints of Selected Methods for the Analysis of Vitamin A and Carotenoids in Nutrition Surveys* (1982)
- *Periodic Large Oral Doses of Vitamin A for the Prevention of Vitamin A Deficiency and Xerophthalmia: A Summary of Experiences* (1984)
- *The Safe Use of Vitamin A by Women During the Reproductive Years* (1986)
- *Biochemical Methodology for the Assessment of Carotenes* (1987)
- *A Decade of Achievement: The International Vitamin A Consultative Group (IVACG) 1975–1985* (1987)
- *Guidelines for the Use of Vitamin A in Emergency and Relief Operations* (1988)
- *Vitamin A Supplements: A Guide to Their Use in the Treatment and Prevention of Vitamin A Deficiency and Xerophthalmia (published by the World Health Organization in conjunction with IVACG and UNICEF, 1988)*
- *Methodologies for Monitoring and Evaluating Vitamin A Deficiency Intervention Programs*

These reports are available free of charge to developing countries and for $3.50 (U.S.) to developed countries. Copies can be ordered from the IVACG Secretariat.

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Contents

Foreword

Increased risk of mortality and of morbidity among children is reported to be associated with subclinical vitamin A depletion. These health-related consequences of an inadequate vitamin A status are in addition to the well-established consequences for the visual system of vitamin A deficiency. The associations are well known to researchers working with depleted and deficient animal models, but must be confirmed among human populations existing in environments where there are many contributing factors with potential adverse consequences for health. As part of intervention trials and for other descriptive studies, dietary patterns of vitamin A intake are a desired part of the epidemiological data for intracountry and cross-cultural comparisons, and for development of appropriate nutrition and health education messages to change adverse situations and practices.

These IVACG guidelines to dietary assessment of vitamin A intake were developed with a focus on the problems of nonindustrialized countries. In some communities, the diet is so uniform and low in vitamin A sources that there is no need for a dietary assessment to establish that they are at high risk of an inadequate intake. In other communities, the situation is less certain. These guidelines apply to the latter situation. Their purposes are:

1. To assist those who not only wish to group populations by risk of an inadequate intake for research purposes, but also must decide on cost-effective, appropriate follow-up interventions.
2. To assist all types of field workers working with the community for better health, nutrition, and social conditions to give individual mothers with high-risk children appropriate direct advice in feeding them within the resources they have available locally and can afford as identified by the locally adapted dietary questionnaire.

The information included in chapter I is general, that in chapters II, III, and IV useful to those responsible for developing the dietary assessment tools, and that in chapters V and VI of interest mainly to those responsible for intervention program planning and development.

These guidelines have been in the developmental stage for several years. The text reflects the collective experiences of the task force members and the critique of several reviewers too numerous to mention individually. Among those to whom special thanks are due for their helpful critiques are Franz Simmersbach, Robert Weisell, Walter Willett, Gladys Block, and Erica Wheeler. The step-wise procedure has been tried in several countries (Benin, Indonesia, and Mexico) by some members of the task force and elsewhere (Bangladesh) by a few other professionals (Mohammad Abdullah and Luthfor Ahmed). Refinements have been incorporated based on these experiences. We are grateful to FAO Food Policy and Nutrition Division for partial financial assistance in conducting these field trials.

Ongoing field applications of the guidelines incorporated into larger vitamin A intervention projects are supported by a variety of funding sources. The committee is grateful to many agencies that have been eager to incorporate the procedure into their applications without expense to IVACG, such as AID, Washington, D.C.; the Ford Foundation in India; and the National Eye Institute, Bethesda, Maryland.

Those who have experience with the step-wise procedure have found the approach to be most educational and helpful in practical situations. The validity of the guidelines in categorizing "risk" groups is still being tested by comparison to other methods of dietary assessment, and in some cases by biochemical and clinical measurements. In Bangladesh, testing revealed that compared with a three consecutive day weighing method, the IVACG guidelines correlated well in identifying children as *groups* at risk of inadequate vitamin A *intake* (the identified purpose of the guidelines) but that the probability of misclassification of a *particular* child into a *particular* risk category for vitamin A *status* was large, thus necessitating additional clinical and/or biochemical assessment parameters when dealing with risk of inadequate vitamin A *status* of individuals. Requests for immediate assistance by field workers have prompted IVACG to move toward publication of provisional guidelines, realizing that revision will be necessary as experience and data from validity testing continue to be accumulated.

Almost all workers will agree that the sustainable long-term solution to the problem of an inadequate vitamin A status is to improve dietary intake of vitamin A. For many populations, this will involve behavioral changes in food intake patterns, particularly among children. Since for the most part mothers control the dietary intake of young children, changing their child-feeding behaviors is critical. We have much to learn about effective approaches to bring about these changes among mostly illiterate populations and mothers. The task force hopes that the location-specific dietary assessment approach advocated in these guidelines will contribute to developing more effective behavioral change interventions. We invite users of these guidelines to communicate their experiences to IVACG. IVACG considers these dietary assessment guidelines as an emerging document that will be changed and updated as users adapt it to their situations and as further documentation and validation of the risk index categories are obtained. Accordingly, the guidelines have been published in looseleaf format to facilitate updating. To receive updates, please complete the registration form at the back of the book and return to the IVACG secretariat.

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A Dietary Approach to Reducing Vitamin A Deficiency

I

The Problem Defined

Clinical vitamin A deficiency still afflicts large numbers of children around the world and is a known public health problem in south and east Asia, parts of Africa, and Latin America. The World Health Organization estimates that as many as 500,000 children suffer annually from active corneal disease, with many progressing to blindness, and 6 million to 8 million suffer from milder forms of deficiency that may be associated with increased risk of respiratory and gastrointestinal infections and even death. The number at risk subclinically of inadequate body reserves is estimated to be five- to tenfold greater. These estimates are only approximations. The true magnitude of the problem and its geographic and demographic distribution remain unassessed in much of the world. In part, this results from lack of readily available, standardized quantitative measures of vitamin A status in the absence of clinical eye signs.

Prolonged vitamin A deficiency leads eventually to partial or total blindness. Under usual conditions this is the result of a prolonged period of an intake of foods with insufficient vitamin A. It is the endpoint of the deficiency continuum. However, it is difficult to measure the earlier points on the continuum because of the limitation of available practical, sensitive, and specific indicators of subclinical deficiency. Because habitual dietary inadequacy precedes all other manifestations of deficiency, it would be useful to have a simplified means of classifying populations and individuals into categories of risk of deficiency on the basis of usual dietary intake.

Dietary assessments that accurately reveal usual intakes are difficult to conduct even among literate, highly educated individuals. They are even more difficult to conduct simply and quickly in population surveys. Fortunately, the problem of applying a field-applicable method is lessened if the purpose is restricted to determining intake of a particular nutrient that occurs in substantial amounts in a limited number of foods. Substantial amounts of preformed vitamin A occur naturally almost exclusively in animal foods, and provitamin A (certain carotenoids) occur in plant foods. Among animal food sources the concentration varies widely among flesh foods and dairy products. For most populations animal food sources are relatively expensive and are common only in the usual diets of populations where vitamin A deficiency is rare. Fortification of multiple food products with preformed vitamin A further complicates assessment of vitamin A intake among many populations in industrialized nations.

On the other hand, provitamin forms—vitamin A-active carotenoids—are widely distributed in dark green leafy vegetables, yellow vegetables, yellow cereals and tubers, yellow citrus and other red and yellow fruits, and red palm oil. These forms of vitamin A activity are more universally available and cost less than animal products. In most low-income populations carotenoids constitute 80% or more of the foods eaten that contain vitamin A activity. Unfortunately, where blinding malnutrition is a significant public health problem, these carotenoid-containing foods are usually excluded from the diet of children during the vulnerable period of weaning and in the postweaning diet through the preschool years. It is during these periods in a child's life when blinding malnutrition generally occurs.

The risk of blindness is greatest at young ages, when physiological needs are greatest, and lessens as people get older. Infants are born with minimal vitamin A reserves. These reserves may be spared initially by the readily absorbable vitamin A in breast milk from an adequately nourished mother. The body reserves of the nursing infant may remain low, however, if breast milk is almost the sole source of vitamin A in the latter period of infancy and early childhood, and/or if it is provided from a mother habitually consuming a diet low in the vitamin. Thus, young children, along with women who experience repeated pregnancies and lactations, are likely to be at greatest risk of being marginally or clinically deficient. It would be especially useful for prevention program purposes, therefore, to be able to effectively categorize the habitual level of vitamin A intake during late infancy, early childhood, and a woman's reproductive years among populations whose intakes are almost entirely from provitamin A carotenoid sources.

Purpose of These Guidelines

The intent of these guidelines is to provide a simplified dietary approach to risk assessment for a habitual inadequate intake of vitamin A, which would supplement the guidelines that the International Vitamin A Consultative Group (IVACG)[®] developed for the clinical and biochemical assessment of vitamin A status. It is also the intent, through the locally adapted dietary intake form (see Chapter IV and Appendix III), to provide educational information to field workers and to professionals with limited knowledge of nutrition and food composition, yet who are working in communities for the betterment of health, nutrition, and social conditions.

The three approaches—clinical, biochemical, and dietary—form an assessment package. Used as such, the package provides the best measure of relative vitamin A nutritional status of both populations and individuals. When it is not possible to apply the complete packaged approach, the simplified dietary guidelines alone may be useful in categorizing relative levels of dietary adequacy of communities. This categorization, used with some knowledge of food preparation practices and disease frequency patterns, can be used to rank communities and individuals into high-, medium-, or low-risk groups for vitamin A inadequacy. This ranking, together with other information provided by the approach, can be a basis for deciding whether risk of inadequacy merits dietary and/or other forms of intervention and, if so, which approach is most likely to be successful.

It should be stressed that IVACG is not developing guidelines or promoting the application of tools for assessment—dietary, biochemical, or clinical—as a sterile exercise. Rather, the most important objective of doing an assessment is to show clearly the link with possible interventions to correct situations where inadequate vitamin A status exists.

Appropriate Uses of a Simplified Dietary Approach

The supply of vitamin A is derived almost entirely from plant sources in the diets of many poor populations. Food composition tables can be used for classifying these foods into groups of high, moderate, or low levels of vitamin A activity. However, many are seasonal foods, which limits the frequency of intake over long time spans. Because vitamin A can be stored in the body to be used during periods of short-term dietary inadequacy, seasonality and frequency adjusted over time must be considered when assessing usual intake to establish risk groups. A simplified approach, however, is *not* strictly quantitative, and there are definite limitations in how the information can be used. The appropriate uses of the simplified approach include the following:

1. Epidemiological studies among populations in which the major food sources of vitamin A activity (more than 70-80%) are from plants and where the goal is to categorize the population into *risk levels* of dietary inadequacy. That is, the simplified approach may not be useful where 50 percent or more of the intake of vitamin A comes from preformed (animal) food sources because of the wide variation in vitamin A concentration in these foods, as it occurs both naturally and as fortificants.

2. Surveys of areas suspected of having a problem of vitamin A deficiency, where this information can help to identify groups for whom more intensive investigations or interventions may be warranted.

3. Identification of children likely to be at high risk of deficiency from whom additional biochemical, clinical, and medical history information should be obtained, because the dietary assessment alone may be insufficient to determine if an individual's vitamin A status is inadequate. Interpretation of these data for individuals requires professional expertise.

4. Evaluation of a nutritional intervention with the objective of increasing vitamin A intake from food sources.

The simplified dietary assessment method outlined in these guidelines, when appropriately adapted to the local context in communities or among individuals, also provides information on the general patterns of preparation and consumption of vitamin A-containing foods. This information should suggest to decision makers interventions that are likely to be culturally accepted, feasible, and cost-effective on the basis of locally available foods and resources. It will also help to determine if external food sources or supplements will be required to increase the level of intake.

To emphasize an earlier point, simplified dietary assessment methods will not provide precise quantitative information on level of intake and alone will not be adequate for a quantitative assessment of the vitamin A status of either communities or individuals. Cause and effect relationships for clinical conditions cannot be established by the simplified approach, although risk level can be determined.

Intended Users

This volume is intended for:

1. Individuals who must decide whether an intervention program is warranted. This decision should be made with the assistance of professionals after considering other relevant indicators, such as clinical and biochemical measurements of vitamin A status.

2. Community planners or program managers who need information on food consumption patterns. This information will assist in designing and evaluating appropriate nutrition education materials and programs targeting the most vulnerable groups.

3. Health and nutrition educators who need information for teaching community nutrition to health aides and nonprofessional field workers.

4. Field workers working with the community for better health, nutrition, and social conditions. Nonprofessional workers should seek professional advice before using the dietary information from the simplified approach as a basis for providing nonfood interventions (such as high-dose vitamin A capsules) to individuals or populations.

Factors to Consider in Estimating the Dietary Intake of Vitamin A

II

One cannot ask, "How much vitamin A do you take?" because people, of course, do not eat vitamin A or any other nutrient. They eat foods, usually not as single items but as a menu or combination of foods. A menu is usually determined by cultural factors and availability within the environment. However, what people eat may not fully reflect what is absorbed. The combination of foods eaten together as well as the health status of individuals can affect the physiological availability of specific nutrients and must be taken into account when interpreting dietary intake information to assess the nutritional impact of single nutrients.

Food Availability

The primary menu of most rural populations in developing areas consists of locally grown foods. The first step, therefore, is to discover the main food items contained in the traditional menu or diet of the community and of the specific sex and age group being investigated, taking care not to forget snacks or street foods. This information might be obtained through casual interviews with a few representative families from the community in a preliminary reconnaissance visit. Additional valuable information may be obtained through discussions with local farmers to determine the food crops grown in the area and by a quick market survey to determine those foods available throughout the year and seasonally. By consulting food composition tables, one can ascertain the relative contribution of these food items to vitamin A intake and use the information to develop a simplified dietary questionnaire (see Chapter IV and Appendix III).

Food Preparation Practices

The vitamin A content of food as actually eaten is affected by the mode of storage and preparation. Care must be taken to find out how the foods are eaten—fresh, boiled, fried, dried in the sun, fermented, ground wet or dry, etc.—and whether this process affects the preformed vitamin A and provitamin A content. These local practices usually are not taken into account in food composition tables for determining vitamin A activity. In general the carotenoids are destroyed or altered by storage or preparation in acid media, particularly in the presence of light. Sun drying and extensive boiling or prolonged cooking are particularly destructive processes, whereas shorter cooking times and canning generally result in only slight losses. Mashing and grinding, which increase exposure to atmospheric oxygen and to inherent degradative enzymes, also are destructive.

Cultural Practices

Foods should always be considered in relation to the culture. To find out which local foods are suitable for prevention of deficiency and are likely to be acceptable in intervention programs, it is important to know the place of different items in the food value system of the community. There are foods that people value and plan to eat a lot of on Sundays, at parties, "when I grow up," or "when I become rich." If there are affordable local foods rich in vitamin A that are high in the value system of the community, the use of such foods can be increased without any problem and should receive the most emphasis in intervention programs. Culture also may dictate what foods are suitable for young children and for women who are pregnant or lactating. The origins of these beliefs should be determined, and nutrition education programs should recognize these and reinforce those that are not nutritionally harmful.

Physiology

Breast milk is a good source of preformed vitamin A and fat that are easily absorbed by the nursing infant. Seldom does clinical vitamin A deficiency occur while breastfeeding continues, at least during first year. Problems of deficiency become evident soon after weaning if the diet does not contain sources of preformed vitamin A or provitamin A. During this period other components of the diet may influence the availability of dietary vitamin A, and these factors must be considered in the dietary assessment. For example, the amount of fat eaten at a given meal is important for the efficient absorption of vitamin A from the foods eaten. Although the amount of fat needed to facilitate absorption may be quite small, it is especially important for the carotenoid-containing plant foods that are the usual major food source. If the fat intake in the diet is adequate, nearly all of the preformed vitamin A and most of the provitamin A in the food items will be absorbed. On the other hand, if the fat level in the diet is very low or nil, much less of the provitamin A-active substances in the foods eaten will be absorbed. Even when the diet contains fat, any factors that interfere with its efficient absorption, such as diarrhea or other diseases that cause fat malabsorption (steatorrhea), will cause fewer vitamin A-active substances to be absorbed. Special consideration needs to be paid to these factors when evaluating the diet of children during and just after weaning. Often the diet during this period is very low in fat, and frequent bouts of diarrhea are common.

Mild or severe protein-energy malnutrition decreases the quantity of vitamin A available to the body. If a mild deficit of protein and energy occurs, clinical signs of vitamin A deficiency may not appear in spite of low intake of the vitamin. This is because growth is slowed under these circumstances and less of the vitamin is required. However, restoring the dietary protein and/or energy deficit can stimulate growth and rapidly bring on clinical symptoms if vitamin A is not also provided. When the protein and/or energy deficit is prolonged and severe, producing clinical signs and symptoms, both the absorption and metabolism of the vitamin are impaired irrespective of the level in the diet. Furthermore, disease states and intestinal parasitism can affect the efficiency of absorption of all nutrients and particularly of carotenoids. Field workers should note the frequency of occurrence of disease patterns, especially diarrhea and respiratory diseases, in communities and individuals.

Some nutrients act beneficially to preserve vitamin A-active substances in the diet. Nutrients such as vitamins E and C act as antioxidants and help preserve the vitamin in the intestinal tract, allowing for greater absorption of vitamin A activity.

Consideration of the environment (seasonal availability of foods and storage and preparation practices), culture (food value systems), and physiology (disease patterns and frequency), therefore, is essential for interpreting dietary intake information in terms of the bioavailability of dietary vitamin A activity and its likely impact on vitamin A nutritional status.

Suggested Readings for Chapter II

Chen, P.V.C. (1972) Socio-cultural influences on vitamin A deficiency in a rural community. *J. Trop. Med. Hyg.* 75:231–236.

den Hartog, A.P., and van Staveren, W.A. (1983) *Manual for social surveys on food habits and consumption in developing countries.* Wageningen, The Netherlands: Centre for Agricultural Publishing and Documentation.

Mahadevan, I. (1961) Belief systems in food of the Telugu-speaking people of the Telengana region. *Indian J. Social Work* 21:387–396.

Tarwotjo, I., et al. (1982) Dietary practices and xerophthalmia among Indonesian children. *Am. J. Clin. Nutr.* 35:574–581.

Vemury, M., and Levine, H. (1978) *Beliefs and practices that affect food habits in developing countries: A literature review.* New York: CARE.

Food Sources of Vitamin A and Determination of Their Vitamin A Activity

III

The food supply of humans contains vitamin A activity either as the preformed vitamin in foods from animals or as the provitamin carotenoids common to plants. Plants that contain carotenoids are the ultimate food source of vitamin A activity. Animals convert much of the carotenoids to preformed vitamin A (retinol). A fatty acid may be attached to the retinol and stored as vitamin A (retinol) esters in several body tissues but mostly in the liver. Some carotenoids are absorbed unchanged. These are found in animal tissues but in relatively small amounts compared with the carotenoids found in the plant kingdom. In a usual diet, the relative contribution of vitamin A from plant and animal sources can vary over a wide range.

Not all carotenoids found in foods have vitamin A activity, and others have only partial activity when compared with beta-carotene. (Appendix I, Table 1, lists some of the carotenoids with vitamin A activity and their common food sources.) Beta-carotene, as found in food, is considered to be 100% active. Because of incomplete absorption (estimated at one-third) and incomplete conversion (estimated at one-half), dietary beta-carotene is assumed to be only one-sixth of the physiological equivalent of retinol. Because of lower efficiency of conversion, other carotenoids are estimated as one-twelfth the equivalent of retinol. Some foods contain several different provitamin A carotenoids and some contain inactive carotenoids. In evaluating a dietary intake assessment, therefore, it is important to know the carotenoid composition of the ingested foods, particularly when vegetable sources make up the primary dietary supply.

Unfortunately, most existing food composition tables do not report food composition in terms of specific carotenoids but instead use a conversion factor based on the assumption that a certain percentage of total carotenoids is beta-carotene. Table 1 shows the commonly

Table 1

Estimated Percentage Distribution of Sources of Vitamin A Activity in Various Foods

	% from Retinol	% from Provitamin A	
		Beta-Carotene	Other Carotenoids
Animal Origin			
Meat and meat organs	90	10	
Poultry	70	30	
Fish and shellfish	90	10	
Eggs	70	30	
Milk and milk products	70	30	
Animal and fish oil	90	10	
Plant Origin			
Cereals			
Maize, yellow		40	60
Other		50	50
Legumes and seeds		50	50
Vegetables			
Green vegetables		75	25
Deep yellow (carrots; sweet potatoes, deep orange type)		85	15
Sweet potatoes, pale type		50	50
Fruits			
Deep yellow (apricot, papaya, mangos)		85	15
Other fruits		75	25
Vegetable oils			
Red palm oil		65	35
Other vegetable or seed oils		50	50

Source: Adapted from U.S. Department of Health, Education, and Welfare and FAO (1968).

used distribution factors for typical food groups. Composition tables that specifically report beta-carotene and/or vitamin A-active carotenoids are expected to be issued, but until these become available, values shown in existing tables will have to be used. This limitation should be kept in mind when individual diets are quantitatively evaluated from existing food composition tables. These factors can be used to adjust values in locally developed food composition data banks, as shown in Table 3. Appendix I gives examples of how to calculate the nutritionally available retinol equivalents (RE, or vitamin A activity) in a diet or foodstuff when the food composition information is given

Table 2

Some Examples of Foods with High and Moderate Amounts of Beta-Carotene

	High	Moderate
Green Leafy Vegetables	Sauropus Amaranth Cassava Papaya Drumstick Sesbania Curry	New Zealand spinach Kangkong Leek Sweet potato Winged bean Bitter gourd Chinese cabbage
Green and Yellow Vegetables (Nonleafy)	Carrot (deep yellow)	Peppers Carrot (light yellow) Squash (yellow) Pumpkin (deep yellow)
Red and Yellow Fruits	Buriti Cashewnut fruit	Apricot Mango (ripe) Barbados gooseberry Papaya Surinam cherry Passion fruit Orange Tangerine Muskmelon
Yellow Tubers	Sweet potato (deep yellow)	Sweet potato (light yellow)
Other Foods	Red palm oil	

as micrograms (μg) or international units (IU) of retinol, beta-carotene, and other vitamin A-active carotenoids.

Appendix II contains a more comprehensive discussion of factors to be considered when dietary intakes of vitamin A activity are evaluated using food composition tables. Among populations where vitamin A deficiency is most often found, carotenoids contribute more than 70-80% of the dietary vitamin A. Generally these are taken in the form of leafy green vegetables, yellow cereals and tubers, yellow citrus and other red and yellow fruits, and red palm oil. A few common examples of food groups with high and moderate levels of beta-carotene are shown in Table 2. The grouping of foods into these categories, of course, will vary somewhat depending on the specific food composition table used as reference.

Suggested Readings for Chapter III

Begum, A., and Pereira, S.M. (1977) The beta-carotene content of Indian edible green leaves. *Trop. Geogr. Med.* 29:47–50.

CTA (Technical Centre for Agricultural and Rural Cooperation) and ECSA (East, Central, and Southern Africa) (1987) *Food composition table for energy and eight important nutrients in foods commonly eaten in East Africa*. C.E. West, ed. Available in poster form from Dr. C.E. West, Department of Human Nutrition, Wageningen Agricultural University, De Dreijen 12, 6703 BC Wageningen, The Netherlands, or Dr. T.N. Maletnlema, Tanzania Food and Nutrition Centre, P.O. Box 977, Dar es Salaam, Tanzania.

C.E. West, F. Pepping, and C.R. Temalilwa, eds. (1988) *The composition of foods commonly eaten in East Africa*. Wageningen, The Netherlands: Wageningen Agricultural University.

INFOODS (International Network of Food Data Systems) (1988) *International directory of food composition tables*. D. Heintze, ed. 2nd ed. Cambridge, Mass.: INFOODS (Massachusetts Institute of Technology).

Oomen, H.A.P.C., and Grubben, G.J.H. (1977) *Tropical leaf vegetables in human nutrition*. Amsterdam: Royal Tropical Institute.

U.S. Department of Agriculture, Agricultural Research Service (1976–84) *Composition of foods: Raw, processed, prepared*. Agricultural handbooks 8–1 to 8–11 (revisions to Handbook 8). Washington, D.C.: Government Printing Office.

U.S. Department of Health, Education, and Welfare and Food and Agriculture Organization of the United Nations (1968) *Food composition table for use in Africa*. Rome: FAO.

Development of a Simplified Approach to Dietary Assessment of Vitamin A Intakes

IV

There are three major objectives for assessing vitamin A intakes in populations: (1) to identify groups at risk of suboptimal intakes and deficiency disease, (2) to design treatment and prevention programs to reach risk groups, and (3) to provide baseline data for program planning and evaluation of intervention strategies.

Assumptions in Developing a Model fo Dietary Assessment

A wide diversity of food sources and seasonal availability, as well as differences in cultural practices and the physiological and economic conditions among countries, make it difficult if not impossible to prepare a universally applicable, preworded, simplified food intake questionnaire with an appropriate data base. Certain guiding principles, however, can lead to the development of a model questionnaire and data bank adaptable to specific situations. The guidelines that are presented here are based on several assumptions:

1. Obtained data should be comparable within and between population groups. Variations owing to available food sources of vitamin A, food preparation methods, and eating patterns of populations should be accommodated within the general model.

2. A professional with only limited specialization in nutrition could independently follow the guidelines and adapt them to local circumstances.

3. Interviewers without specialized backgrounds could be trained to attain objectivity and reliability in the collection of dietary data and in determining the relative risk of a habitual inadequate intake of vitamin A.

4. Because vitamin A deficiency does not develop within a few days, the assessment approach should provide a consumption history. The time period covered should depend on the uniformity of the diet, but it should usually be one year, so that the history will reflect seasonality.

5. The frequency of usual intake of selected vitamin A sources that provide about 90% of the total intake should be represented. (Generally, in societies where sources of vitamin A from preformed sources are many, a minimum of a one-week recall of intake frequencies, along with information on portion sizes, seasonal items, and history of usual intake covering a one-year interval, is necessary for reliably estimating intakes. However, in many situations where vitamin A deficiency occurs, the diet is highly uniform, except for a few seasonal foods, and the preformed sources of vitamin A are very limited. This applies especially to the diets of young children from low-income families. In these situations a simple 24-hour recall record of frequency of intake by serving size, combined with a history of usual intake pattern that covers seasonally available foods high in vitamin A, is sufficient.)

6. Because amounts of foods consumed will vary by age and sex in a population, the dietary assessment approach should permit adaptation to individual variations in both frequency and quantity of food consumption.

7. The population of concern is usually young children (or pregnant and lactating women). Foods fed to young children are likely to be selected from a family's food supply. Therefore, qualitative information on the household's dietary intake covering the same time period as the child's intake is desirable. These data provide useful information for planning nutrition education and intervention programs.

With these considerations in mind, the model assessment approach is designed to provide frequency and semiquantitative intakes for children (or individuals) in the household.

Developing and Interpreting a Locally Useful Dietary Questionnaire to Assess Usual Dietary Intake of Vitamin A

This section provides a step-by-step procedure for developing a locally adapted, simplified approach to assessing vitamin A intakes in communities or regions where no previous surveys have been taken (or where few secondary data are available).

Steps to Be Taken Before the Interviews

1. *Identify all sources of vitamin A.* A preliminary survey of the community stores and household gardens should identify readily available and potential food sources of retinol (preformed vitamin A) and carotenoids (Table 1). Researchers should also obtain information on food items imported to the area, such as canned vegetables, yellow

cereals (e.g., maize), dried milks, infant formulas, or foods fortified with vitamin A. Attention should be paid to snack foods available from street vendors. Furthermore, if vitamin supplements are sold or distributed, data on the potency of vitamin A per pill should be collected.

In poor communities the available and potential major sources of vitamin A may be small. For this reason, the preliminary survey should include all potential food sources of retinol and carotenoids. Sources not seen in the marketplace but available in the wild should be assessed. In some cases the amount of vitamin A per usual serving may be small, but if the item is consumed frequently (as is sometimes the case with green lentils, yellow maize, or snack items), the contribution to the diet may be considerable.

2. *Determine dietary patterns and preparation methods.* Community leaders, health workers, teachers, and mothers should be asked to identify the usual dietary patterns and preparation methods for foods containing vitamin A. If special procedures are used for young children, these should be ascertained. For dishes containing some combination of cereal grains, lentils, and vegetables, representative recipes should be obtained so that the nutrient composition can be calculated. Those mixed food dishes that contain vitamin A should then be added, using their local names, to the dietary questionnaire and the food composition data bank (see Step 4, and Appendix III, Tables 3–5 and 9).

3. *Determine portion sizes.* The usual portion sizes (small, medium, and large) by specific age and sex group should be determined. For example, serving sizes will vary for preschool-age children (2–5 years), school-age children (6–10 years), adolescents, and adults. Portion sizes must be determined based on the age span of the population to be studied. This may be done in several ways. Community workers can be trained to collect a limited sample of 24-hour dietary recalls in which amounts of foods eaten are estimated. In this case, the mother or caretaker is asked to fill serving or eating utensils with water to illustrate the volume consumed by the child. Quantities are estimated by transferring this water into standard measuring spoons, cups, or bowls. Equivalent gram weights of the measured foods are obtained by direct weighing or from published food composition tables. Another possibility is to equip the interviewer with a small scale that has a 1,000-gram

capacity. The mother is asked if a sample of the particular food consumed is available, and both measurement and weight of the item are obtained simultaneously. All of this information is then used to estimate the typical size of small, medium, and large servings of each food item.

One way of facilitating the effort to obtain semi-quantitative recall information is to illustrate the portion sizes with color or black-and-white photographs (each picture should depict the three portion sizes), Styrofoam food models, locally used eating and serving utensils (spoons, cups, glasses, bowls, plates), cardboard cutouts, or drawings. Ideally, for each food item there should be visual objects to assist the person interviewed in estimating portion sizes consumed; e.g., a picture of three portions (small, medium, and large) of a particular leafy green vegetable could represent several different leafy vegetables. The person might select any combination or multiple of the visuals to estimate intakes. The more lifelike the visuals, the greater the chance of obtaining a valid response. If photographs are used, it also is advisable that the interviewer show the plate used in the picture to give a sense of scale. However, this approach may be ineffective for some groups unfamiliar with photographs or models. In these cases it may be necessary to use the actual food items displayed in the varied serving sizes or to allow the person to portion out the amount usually fed. The questionnaire can be used not only to record the usual diet of an individual but also to check the food items consumed by the family or household members during the same period. For literate populations a possible alternative is to ask selected mothers to keep a food diary for three or four days in which quantities of foods consumed by their children are measured or estimated.

4. *Compile food composition data on the locally available food sources of vitamin A.* A variety of sources are published by groups in the United States, Japan, the United Kingdom, and elsewhere (INFOODS 1988). Ideally, the data should derive from the original analysis of the total preformed vitamin A, beta-carotene, and other carotenoid content of foods produced in the geographic area of interest. However, data, and food composition tables reporting such data, are often not available. When such is the case it is best to rely on relatively recent regional or country tables that report

the results of original analyses as retinol equivalents, retinol, or beta-carotene equivalents. Information given in Table 1 and Appendix I provides guidance on how to use appropriate conversion factors in arriving at retinol equivalents.

If the food composition data bank is based on 100-gram units of foods, vitamin A (or retinol) equivalents (RE) can be calculated for typical portion sizes, and from this a vitamin A score (*H*igh, *M*oderate, or *L*ow) can be assigned to the food based on the smallest usual serving size. Table 3 shows one example of how to develop a food composition data bank from locally available foods and serving sizes in order to arrive at a vitamin A score for individual foods. Once determined, the vitamin A score for relevant local foods should be transferred under appropriate headings (*H*igh, *M*oderate, or *L*ow) to the dietary questionnaire (see step 5).

5. *Prepare precoded questionnaire.* Based on the information obtained from steps 1-4, the health professional should prepare a simplified, structured, precoded questionnaire listing those selected dietary items that together contribute 90% or more to the vitamin A intake. An example of a format for such a dietary questionnaire is shown in Table 4. The questionnaire should list the food items under the appropriate heading for vitamin A score (*H*igh, *M*oderate, or *L*ow) taken from the food composition data bank (Table 3). Columns should be provided for recording the frequencies of ingestion of small, medium, and large portions in the past 24 hours.

Because of daily variations in vitamin A intake, the record of vitamin A intake in the past 24 hours should be complemented by a dietary history of the usual pattern of consumption of vitamin A-rich foods (Table 4). Food items are again listed as *H*igh, *M*oderate, or *L*ow sources of vitamin A. Columns should be provided for recording the frequency of consumption as daily, weekly (one to three times per week), and monthly (one to three times per month). (A column labeled *never* might be added when it is anticipated that the questionnaire will be used to educate those interviewed.) This allows the field worker to know which of the locally available sources of vitamin A to advise the mother to use and how frequently.

In most communities, particularly in rural areas, the local availability of potentially rich vitamin A sources depends on the season. In these cases, the dietary history records should cover the different seasons of the year.

Table 3

Example of a Model for Establishing a Food Composition Data Bank Based on Local Foods and Serving Sizes for Preschool-Age Children

Local Food	Serving Size[a] Small	Medium	Large	Vitamin A Activity (RE[μg]/100 g)[b]	Vitamin A Score[c]
Milk					
Cow's milk, whole	¼ cup (60 g)	½ cup (120 g)	1 cup (240 g)	38	
RE[d]	23	46	93		*L*
(Other locally consumed milks)					
Green Leafy Vegetables					
Amaranth, cooked	1 tbsp (25 g)	2 tbsp (50 g)	¼ cup (100 g)	1,280	
RE	320	640	1,280		*H*
Drumstick, cooked	1 tbsp (25 g)	2 tbsp (50 g)	¼ cup (100 g)	1,500	
RE	375	750	1,500		*H*
Bitter gourd, cooked	1 tbsp (25 g)	2 tbsp (50 g)	¼ cup (100 g)	850	
RE	213	425	850		*M*
Spinach, boiled	1 tbsp (25 g)	2 tbsp (50 g)	¼ cup (100 g)	610	
RE	152	305	610		*M*
(Other locally consumed green leafy vegetables)					
Green, Yellow, and Red Vegetables (Nonleafy)					
Carrot, dark yellow, cooked	2 tbsp (20 g)	¼ cup (40 g)	½ cup (75 g)	2,554	
RE	480	960	1,915		*H*
Carrot, light yellow, cooked	2 tbsp (20 g)	¼ cup (40 g)	½ cup (80 g)	1,167	
RE	233	467	934		*M*
Pumpkin, boiled	2 tbsp (12 g)	¼ cup (25 g)	½ cup (50 g)	130	
RE	16	33	65		*L*
(Other locally consumed nonleafy vegetables)					
Fruits					
Banana, 6-inch, ripe, raw	¼ cup (25 g)	½ cup (50 g)	1 cup (40 g)	40	
RE	10	20	40		*L*
Papaya, ripe, raw	⅛ cup (50 g)	¼ cup (100 g)	½ cup (200 g)	200	
RE	100	200	400		*M*
Mango, ripe, raw	¼ cup (25 g)	½ cup (50 g)	1 cup (100 g)	390	
RE	100	195	390		*M*
Muskmelon, raw	2 tbsp (30 g)	¼ cup (60 g)	½ cup (120 g)	284	
RE	85	170	340		*M*

(continued on next page)

Table 3 *(continued)*

Local Food	Serving Size[a] Small	Medium	Large	Vitamin A Activity (RE[μg]/100 g)[b]	Vitamin Score[c]
Jackfruit, raw	2 tbsp (25 g)	¼ cup (50 g)	½ cup (100 g)	30	
RE	7	15	30		*L*
(Other locally consumed fruits)					
Meat, Fish, Poultry, Eggs					
Eel, river, raw	1 oz. (21 g)	2 oz. (42 g)	3 oz. (85 g)	860	
RE	182	365	730		*M*
Catfish, river, raw	1 oz. (21 g)	2 oz. (42 g)	3 oz. (85 g)	85	
RE	24	48	72		*L*
Egg, chicken, whole	¼ cup (12 g)	½ cup (24 g)	1 cup (50 g)	530	
RE	63.6	127	265		*M*
(Other locally consumed meat, fish, poultry, eggs)					
Yellow Cereals					
Maize	2 tbsp (15 g)	¼ cup (30 g)	½ cup (60 g)	50	
RE	8	15	30		*L*
(Other locally consumed yellow cereals)					
Tubers					
Sweet potato, light yellow, cooked	2 tbsp (25 g)	¼ cup (50 g)	½ cup (100 g)	280	
RE	70	140	280		*M*
Sweet potato, deep yellow, cooked	2 tbsp (25 g)	¼ cup (50 g)	½ cup (100 g)	2,182	
RE	545	1,091	2,182		*H*
(Other locally consumed tubers)					
Fat					
Red palm oil	1 tsp (5 g)	½ tbsp (8 g)	1 tbsp (15 g)	13,640	
RE	682	1,023	2,046		*H*
Butter, cow's	1 tsp (15 g)	½ tbsp (22 g)	1 tbsp (45 g)	650	
RE	97	143	292		*M*
(Other locally consumed fats)					

[a]Appropriate serving size in commonly used measures and conversion to gram weights are determined by the preliminary visit to the community.
[b]Vitamin A activity (μg/100 g or RE/100 g) is obtained from an appropriate food composition table or from direct laboratory analysis locally.
[c]For the purposes of these guidelines, foods are ranked by their relative level of RE in a small serving size: *L* (low) = less than 50 μg; *M* (moderate) = 50–250 μg; *H* (high) = greater than 250 μg.
[d]RE = retinol equivalents vitamin A activity for each serving size (see Appendix I for additional definitions) calculated per serving size as:

$$\frac{\text{grams per serving}}{100} \times \mu g\,(\text{RE})/100\,g$$

As noted earlier, breast milk contains significant amounts of vitamin A. Therefore, information on current or previous breast-feeding history should be recorded and accounted for later in calculating the risk of dietary inadequacy.

If vitamin supplements are consumed, the name of the supplement, usual frequency of use, and amount of vitamin A in the dosage should be recorded.

It is also important to determine whether fat is eaten in the meal, because the absorption of vitamin A, especially provitamin A carotenoids, is facilitated by dietary fat intake. Although the amount of fat or oil used in food preparation and with the final product may be difficult to quantify, qualitative information on the sources and frequencies of use should be obtained. The interviewer should ask about the preparation techniques that include fat, such as frying in coconut oil or adding of coconut milk to boiled greens. The interviewer should also ask whether any foods in the meal are consumed with fat, such as dipping in fish oil or using butter. A particularly important example is the actual or potential use of red palm oil, because this can be a very significant source of vitamin A activity as well as a fat source (see the information on Benin in Appendix III).

NOTE: *In communities or regions where considerable secondary information is available*, a trained nutritionist at the central office could perform steps 1 through 5, that is, identify locally available food sources of vitamin A and usual preparation methods and portion sizes, and prepare a precoded questionnaire and food composition data bank from available secondary data. A subsequent visit to the local site would be needed to verify and, if necessary, modify this information, taking into consideration the local cultural constraints.

6. *The questionnaire should always be pretested in the community and revised as indicated to ensure objectivity, validity, clarity, and reproducibility.* Several pretests may be needed before the actual form of the questionnaire is ready to be used.

In addition, before using the questionnaire, the interviewer should be trained in methods of asking questions, probing techniques, etc. A useful approach is to ask the mother or caretaker in a chronological way (e.g., from morning, when the first food is eaten, until the child goes to bed), "What did your child eat and drink yesterday?" This question is followed with another on the estimated

Table 4

Example of a Dietary Questionnaire

Name ______________________ I.D. number ______________________

Address ______________________ Date ______________________

Birth date ______________________ Age __________ Sex __________

Breast-fed: Current: Yes _____ No _____ Previously: Yes _____ No _____

Number of months __________

Vitamin A supplement: Yes _____ No _____ If yes, name of supplement ______________________

Number/week ______________________ Amount vitamin A/pill ______________________

Season ______________________

Foods Consumed During Past 24 hours[a]	Frequency/24 Hours Serving Size			Usual Pattern		
	Small	Medium	Large	Day	Week	Month
Vitamin A Score[b]H						
Total number =						
Vitamin A Score M						
Total number =						
Vitamin A Score L						
Total number =						

Food sources fat: ______________________

[a]The particular foods listed should be based on available sources of vitamin A in the particular geographic area and should be listed using local names.

[b]Score obtained from food data bank developed locally (see Table 3, note C).

portion size consumed for each time the child had eaten a food containing vitamin A. After the 24-hour record is completed, the usual pattern of intake questions is asked. The first question would be, "Are there other foods that the child usually eats and drinks in this season daily, weekly, and/or monthly?" Since all the significant potential sources of vitamin A are listed on the dietary questionnaire form, one may cross-check answers to assist the mother's or caretaker's memory.

During data collection, experienced professionals should accompany interviewers periodically as a means of ensuring quality control. A sample dietary questionnaire is shown in Table 4, and examples of its use are included in Appendix III.

Conducting the Interview Assessment to Account for Seasonality

In most areas, the intake of many vitamin A sources (particularly carotenoids) varies according to season of the year. This problem may be handled in several ways. First, the section of the dietary questionnaires for usual dietary pattern may be applied separately by questions appropriate to food items available in each season of the year. The preliminary visit to the community should have revealed seasonal availability. Readministering the questionnaire should help the mother recall the usual frequency of consumption and serving size of foods available in each season.

Another way of accounting for seasonality involves finding the time of year when food is most limited (hunger season in many populations) and conducting the dietary assessment then. If the intake of vitamin A during the most limited season is adequate, little risk of vitamin A deficiency is to be expected.

Whichever approach is selected, the interviewer must be carefully trained to apply the approach consistently so that the contribution of seasonally available foods to the overall diet can be properly evaluated.

Evaluating the Dietary Questionnaire

The dietary questionnaire can be evaluated in one of two ways. When the dietary pattern in the past 24 hours is found to reflect the pattern over time, a consumption index is calculated from which a risk category score is derived. When this is not the case, i.e., the usual pattern of food consumption (UPF) differs from the 24-hour record, a UPF score is calculated to arrive at a risk category. Usually, determination of the UPF score will be the appropriate evaluation path to follow to arrive at a risk category.

1. A consumption index (CI) is calculated from the dietary questionnaire in such a way that all servings are converted to their equivalent in small serving sizes of foods of a *L*ow vitamin A score (less than 50 RE/100 g). Assuming that the medium-size and large servings are two and four times larger than the small serving, the frequency of consumption of medium-size servings is multiplied by 2, and the frequency of consumption of large servings by 4, to convert them to the equivalent number of small servings. For foods with *M*oderate and *H*igh vitamin A scores, one multiplies the average retinol equivalents for each grouping by the factors 3 and 5, respectively, to compensate for the higher levels of RE, so that one arrives at an average of 150 RE (3 × 50 RE) for *M*, and an average of greater than 250 RE (5 × 50 RE) for *H*. (If the food composition data bank is based on different relationships between serving sizes, the appropriate factor should be substituted.) To arrive at the CI, one takes from the dietary questionnaire the total number of small, medium, and large servings in the last 24 hours of foods with each of the three vitamin scores (see Table 4), then applies the appropriate multiplication factors (see Table 5). This score is adjusted for subjects currently breast-fed (Table 7).

The assignment of *risk category* is based on the FAO/WHO's recommended dietary intake for preschool-age children of 350 RE daily (2,450 RE weekly). A child

Table 5

Calculation of Consumption Index (CI)

Vit A Score	Multiplication Factor	Serving Size: Small	Medium	Large
		(1)	(2)	(4)
L	1	(f[a] × 1 × 1)	(f × 1 × 2)	(f × 1 × 4)
M	3	(f × 3 × 1)	(f × 3 × 2)	(f × 3 × 4)
H	5	(f × 5 × 1)	(f × 5 × 2)	(f × 5 × 4)
	Sum =			

Total score = ____________________

[a]f = total number of servings in last 24 hours, taken from dietary questionnaire.

with a total CI (based on daily intake) of greater than 7 (7 × 50 RE = 350 RE) would in theory meet the recommended dietary intake and be at low risk. It is assumed that this amount will supply adequate vitamin A without depleting body stores. Generally it is assumed that intakes habitually less than two-thirds of the recommended intake will cause depletion and place a child at high risk. The CI value of less than 5 (5 × 50 RE = 250 RE) for the high-risk category was arrived at from this assumption. The relative levels of risk categories based on the CI are:

scores greater than 7	=	low risk
scores 5–7	=	moderate risk
scores less than 5	=	high risk

Appropriate adjustments in the weighting factor for calculating the CI must be made to determine the risk category for age groups with higher recommended intakes.

2. The dietary history is meant to complement the information from the 24-hour recall by providing information on the usual pattern of food consumption (UPF) by season. When the 24-hour consumption pattern does not reflect the usual pattern of intake, the risk assessment must be adjusted to take the UPF into account. To arrive at UPF-adjusted risk categories, one first determines a *UPF score* by assigning a weighting factor for the usual pattern of consumption (daily, weekly, and monthly) of foods with a vitamin A score of *H* (greater than 250 RE per small serving). A weighting factor of 1 corresponds to 50 RE. If the period under consideration is one month, then a daily intake of an *H* category food would correspond to 30 days × 5 points = 150 points. If one assumes weekly consumption means an intake of one to three times, the score may be calculated on the basis of three times per week, i.e., 3 days × 4 weeks × 5 points = 60 points. Similarly, assuming monthly consumption entails an intake of one to three times, the score may be calculated as 3 days × 5 points = 15 points. These weighting factors are then adjusted downward by approximately three-fifths (150/250 RE) for *M* category foods and one-fifth (50/250 RE) for *L* category foods. A summary of the UPF scoring is presented in Table 6.

The risk levels for the UPF score are based on the safe level of vitamin A intake of 350 RE/day (2,450 RE/week) and the basal requirement of 200 RE/day for preschool-age children. Thus the relative levels of risk categories based on UPF scores are:

scores greater than 210	=	low risk
score 120–210	=	moderate risk
scores less than 120	=	high risk

3. Both the CI and the UPF need to be adjusted for infants and children who are still breast-fed. It is known that breast-feeding protects against clinical vitamin A deficiency because of breast milk's content of bioavailable vitamin A. The variation in the amount of breast milk consumed is large, as is the vitamin A content of breast milk. For practical purposes one may assume that on average children aged 0–6 months, 7–12 months, 13–24 months, and over 24 months daily consume 600 g, 400 g, 200 g, and 100 g of breast milk, respectively. On average breast milk can be considered to contain 50 RE per 100 g. The additional scores for the CI and UPF are calculated and presented in Table 7.

4. Table 8 provides an example of a model scorecard that summarizes the information needed for determining risk of an inadequate intake of vitamin A.

In areas where dietary patterns are variable, the risk category indexes arrived at from the CI and UPF are likely to differ; one may be high and the other low. The UPF risk index should be considered the more reliable since it reflects long-term patterns of food ingestion.

Appendix III contains examples of how these guidelines for development and interpretation of a dietary assessment have been applied in different settings. Additional adaptations and applications, ongoing in other settings, are likely to yield still simpler reliable ways of assessing risk of inadequate intake of vitamin A nutriture.

Table 6

Calculation of UPF Score

RE Category	Frequency of Consumption: Daily	Weekly (1–3)	Monthly (1–3)
High	30 days × 5 (150)	3 days × 4 weeks × 5 (60)	3 days × 5 (15)
Moderate	3/5 × 150 (90)	3/5 × 60 (36)	3/5 × 15 (9)
Low	1/5 × 150 (30)	1/5 × 60 (12)	1/5 × 15 (3)

Table 7

Additional Scores for Breast-Fed Infants and Children[a]

Age (Months)	Average Breast Milk Intake per Day (Grams)	CI	UPF
0–6	600	6	180
7–12	400	4	120
13–24	200	2	60
25+	100	1	30

[a]Breast milk assumed to contain 50 RE/100 g.

Table 8

Model Scorecard for Determining Risk[a] of an Inadequate Intake of Vitamin A

A. Consumption Index

Vitamin A Score	Servings per 24 Hours (f) Serving Size: Small	Medium	Large	Equivalent in Small Servings	Multiplication Factor	CI
H	f × 1	f × 2	f × 4		× 5	
M	f × 1	f × 2	f × 4		× 3	
L	f × 1	f × 2	f × 4		× 1	

CI + breast-feeding adjustment = risk index.

B. Usual Pattern of Food Consumption

Vitamin A Score	Daily	Weekly	Monthly	UPF Score
H	f × 150	f × 60	f × 15	
M	f × 90	f × 35	f × 9	
L	f × 30	f × 12	f × 3	

UPF score + breast-feeding adjustment = risk index.

[a]Risk index interpretation:

	CI	UPF
High	< 5	< 120
Moderate	5–7	120–210
Low	> 7	> 210

Educational Merits of the Dietary Questionnaire

Besides using the information on the dietary questionnaire to assess risk categories, the interviewer can also use it to educate mothers whose children are at risk of an inadequate intake of vitamin A or to reinforce good dietary practices with regard to the intake of vitamin A-rich foods. For example, including the term *never* in the questionnaire would allow the interviewer to note vitamin A-rich local foods that are excluded from diets and that could be added. The interviewer can ask the mother why a given food is excluded and determine if she is willing to change her behavior. The interviewer can refer to the local food items listed on the food questionnaire as high and moderate sources of vitamin A in advising mothers which foods to include and how frequently to use them.

The information on risk groups can be used by interviewers to make immediate decisions on whether to advise health professionals that the individual or community is in need of an appropriate intervention program. (See Appendix III for a specific example of how to establish risk groups.)

Some General Considerations

The validity and reliability of the findings applied to population groups will depend on several factors. Researchers should begin with a representative sample of the population to be surveyed. If the population is not too large, all children aged one to five years should be surveyed; the alternative is to select a random sample in this age group. The food composition data bank should reflect the local available food supply to minimize errors arising from data banks developed from remote resources.

From the results of the population survey, it may be possible to identify selected food items with corresponding levels of intake that clearly distinguish between healthy persons and those with signs of vitamin A deficiency. These items and amounts could then be listed on a scorecard, permitting an even simpler rapid assessment of the population, along with a basis for designing interventions.

Initially, a trained nutritionist will need to carry out steps 1 through 6. Once a locally adapted dietary questionnaire, local food composition data bank, and scorecard are developed, the application and interpretation of the questionnaire might be left to trained community workers.

The results from the questionnaire alone can be used to group populations into categories at risk of an inadequate intake of vitamin A. Preferably, the dietary information should be used together with biochemical and clinical information by professionals, or with their assistance, before assigning risk levels of a deficient vitamin A status to individuals or making programmatic decisions regarding the use of vitamin A supplements.

Suggested Readings for Chapter IV

INFOODS (International Network of Food Data Systems) (1988) *International directory of food composition tables*. D. Heintze, ed. 2nd ed. Cambridge, Mass.: INFOODS (Massachusetts Institute of Technology).

Institute of Nutrition of Central America and Panama and Interdepartmental Committee on Nutrition for National Defense (1961) *Food composition table for use in Latin America*. Bethesda, Md.: National Institutes of Health.

Paul, A.A., and Southgate, D.A.T. (1978) *McCance and Widdowsons's "The composition of foods."* 4th rev. ed. London: Her Majesty's Stationery Office.

Resource Council, Science and Technology Agency (1982) *Standard tables of food composition in Japan*. 4th rev. ed. Tokyo: Ishiyaku Publishing Co.

U.S. Department of Agriculture, Agricultural Research Service (1976–87) *Composition of foods: Raw, processed, prepared*. Agricultural handbooks 8-1 to 8-13 (revisions to Handbook 8). Washington, D.C.: Government Printing Office.

U.S. Department of Agriculture and Food and Agriculture Organization of the United Nations (1982) *Food composition tables for the Near East*. Bethesda, Md.: DHEW; Rome: FAO.

U.S. Department of Health, Education, and Welfare and Food and Agriculture Organization of the United Nations (1968) *Food composition table for use in Africa*. Rome: FAO.

U.S. Department of Health, Education, and Welfare and Food and Agriculture Organization of the United Nations (1972) *Food composition table for use in East Asia*. Bethesda, Md.: DHEW; Rome: FAO.

West, C.E., Pepping, F., and Temalilwa, C.R., eds. (1988) *The composition of foods commonly eaten in East Africa*. Wageningen, The Netherlands: Wageningen Agricultural University.

Intervention Options Through Food Sources of Vitamin A

V

For the prevention of vitamin A deficiency through dietary measures, the most suitable approach differs from country to country and also from community to community. This chapter is meant primarily to help planners choose the appropriate dietary intervention in various situations. The decision about which intervention to choose should come from knowledge of facts concerning the locale and from the advice of key individuals on technical, management, and political aspects. Intervention may have to be considered at the national, the community, or the family level, depending on the realities of the particular situation. For example, in countries such as Bangladesh and Indonesia, xerophthalmia is limited to certain regions, villages, and even families.

Interventions at the National Level

Several interventions may be implemented nationwide when the deficiency problem is widespread. These may include one or more of the following: (1) increased production of vitamin A-rich food sources, (2) importation of vitamin A-rich food sources, either commercially or through food aid, (3) fortification of an appropriate staple food item or items, (4) logistic measures to facilitate redistribution of vitamin A-rich sources from within the country or region, (5) national campaigns in support of breastfeeding, (6) national mass media educational campaigns, and (7) socioeconomic measures. The opportunities for each of these interventions will now be examined in greater detail.

1. Planning at the national level for increased production of vitamin A-rich food sources is not easy, nor is it quickly accomplished. This approach requires examination of national food policies and an economic analysis of current plans versus their modification in favor of different types of production. Unless the planner is deeply involved in agricultural production planning and has

power of decision at the national planning level, this intervention is not advisable as a first choice or as a short-term measure. Examination of its possibilities should, however, not be excluded as a long-term objective. This would require consultation with agriculturalists and economists to analyze whether the country's situation allows for increased production of animal and vegetable sources of vitamin A, fats, and oils for local consumption in rural and urban areas at costs within the reach of the lower-income at-risk groups.

2. Importing vitamin A-rich foods also requires a policy decision at the national level, which may not be easily and quickly accomplished. In addition to the considerations mentioned under intervention 1, the problem of cost in terms of foreign exchange is certainly an important factor in making a decision. This problem would not exist if the foods were obtained through food aid resources; for example, a number of food aid programs provide foods enriched with vitamin A, such as wheat flour, dry skim milk, and blended foods (corn soya mixture [CSM], wheat soya blend [WSB]), which are suitable for young children, the group at highest risk. Food aid programs are not a long-term solution but may be necessary over a limited time period. If a new feeding program has to be organized, the related costs of distribution need to be considered in terms of logistics, personnel, equipment, and material. These costs may be considerable.

3. Fortification is an intervention to be considered only at the national level. (Some have suggested considering it at the regional level, but this has not been tried and shown to be feasible and cost-effective.) At the national level this intervention can be an effective, comparatively low-cost medium- or long-term measure for improving vitamin A intake. However, it requires careful planning, including studies on the choice of the right type of carrier food, analysis of costs, and, possibly, selection of industrial firms for implementation. Careful development of and enforcement of legislation may also be needed. In addition, consideration must be paid to the long-term availability and cost, in terms of foreign exchange, of the vitamin from external sources if it is not produced within the country.

Fortification as an intervention approach has been implemented in a few countries, and these experiences have shown that the approach requires strong, continued political support to be effective in the long term. Furthermore, it may be more effective and successful in urban rather than in rural areas, the latter often being outside the market economy in developing countries. Although a fortification strategy is attractive because it does not require a behavioral change in poor food intake patterns, where such patterns exist they should be addressed through a concurrent nutrition education program. In developing countries, the most sustainable way of eradicating vitamin A deficiency as a public health problem is through the intake of a balanced diet of available natural foods.

4. Some countries with very different ecological environments may have regions where production of vitamin A-rich foods (vegetable or animal) is plentiful, or possible, and others with very poor potential for such production. Redistribution from one region to another and from rural to urban areas may be impeded by the lack of infrastructure and suitable marketing facilities. To intervene appropriately in these situations may require policy decisions and the allocation of funds for national development of the required infrastructures to improve communication, such as roads, trucks, and trains. This intervention could be a relatively short-term measure, benefiting both plentiful and poor regions as well as urban areas if the basic needs of funds and equipment are met. However, it would also require attention to such related problems as preservation and storage of the transported foods, which are very often of a perishable nature.

5. Campaigns for the promotion of breast-feeding are being launched in several countries as a result of WHO/UNICEF's and other international agencies' efforts in fighting malnutrition. These campaigns will help to fight, among other things, vitamin A deficiency, because breast milk has a demonstrated protective effect against xerophthalmia for the first and probably the second year of life. Where these programs exist, more emphasis could be placed, if appropriate to the situation, on the vitamin A issue; where there are no programs, it may be worthwhile to make an effort to stimulate campaigns, because support of breast-feeding will help ultimately to solve more than one nutrition problem, although certainly not all. Here again, political will and decisions will be needed.

6. National mass media campaigns to convey suitable, meaningful, and effective messages should be considered where the media reach a large percentage of the urban and rural population. If funds are available (and probably not much would be required) and if the problem

of vitamin A deficiency is widespread in a country, this intervention is worth considering, keeping in mind that its effectiveness is limited if it is not supported by other interventions. A media campaign will be difficult to evaluate in terms of ultimate impact. However, mass media techniques have been reported to be quite effective in rural societies, for example, in Nepalese agriculture and nutrition education broadcasts.

7. Socioeconomic measures may also effectively improve the vitamin A intake situation nationally. The intake of vitamin A is closely and positively associated with household income levels. Therefore, measures aimed at increasing income levels will help in combating the deficiency. In most cases the decision whether to adopt such measures is political and would be based on wider considerations than the presence of vitamin A deficiency. In any case, vitamin A deficiency could be added as a further argument and justification in support of new socioeconomic policies at the national level.

Interventions at the Community Level

Interventions worthy of consideration at the community level include: (1) increased local production of vitamin A-rich foods by the community or by families, (2) improvement of the infrastructure for transport and marketing of foods, (3) establishment of food preservation and storage measures to bridge seasonal gaps, (4) food distribution schemes for low-income at-risk groups, and (5) nutrition education activities focused on vitamin A-rich foods. The following discussion briefly examines the merits and constraints of each approach.

1. In locations where the main cause of xerophthalmia is lack of vitamin A food sources, household food production of such sources could be encouraged. To determine whether such production is feasible, information is required on local food patterns; production potential in terms of soil type; needs for fertilizers, seeds, and small equipment; cost of programs in support of low-income families; land and water availability; and use of land by low-income groups. The availability of technical advice and, sometimes, of credit should also be explored.

Establishment and support of community, school, health center, or family gardens is an approach that has been developed in many countries, with variable success. It is certainly worth considering not only vegetable production but also small animal husbandry, fish farming, and production of sources of fat. The latter should be considered in areas where low fat consumption may be significantly reducing the absorption and biological utilization of provitamin A. Planners should also consider stimulating the use of wild foods and perhaps their production, because such foods often are good sources of the vitamin. To implement any of these programs, planners must consult with local agricultural experts and extension workers and obtain their full support.

2. A community may have little potential for local production, but food sources may be plentiful and available in nearby communities. The possibility of transport and redistribution from those communities, perhaps in exchange for a commodity in short supply in the provider community, should be studied.

3. The seasonal appearance of xerophthalmia in certain areas is often linked with the seasonal availability of local produce; there may be a large production in excess of needs in certain seasons and a lack of foods in others. This problem can be solved with relatively limited efforts and resources if suitable processing and storage methods, such as the drying of dark green leafy vegetables and whole fish, are implemented to conserve the foods for lean seasons.

4. Free distribution of foods rich in vitamin A to low-income groups, either directly or through feeding programs, is often accomplished by the government or by local or international voluntary groups. It is easier to use this intervention under the auspices of voluntary agencies, since policy decisions are required if the government is involved. The types of foods need careful consideration because if imported they may be unknown to the people, therefore requiring considerable educational efforts. Imported foods may not solve the problem in the long run unless the foods are acceptable and have potential for local production (or long-term import—a costly measure). In general, programs that provide free distribution of foods are not long-term solutions to the problem of an inadequate intake of vitamin A-containing foods, but such programs may be necessary for short periods.

5. Food, nutrition, and health education activities are an essential aspect of most of the interventions or combination of interventions just outlined. Education activities are especially important when ignorance of the source of the problem is a factor determining the deficiency and when foods locally available at low cost are

not properly utilized. Education would help to overcome some important constraints, especially present at the family level. Pregnant and nursing women may lower their intake of vitamin A when they alter their eating habits because of taboos. Furthermore, certain child feeding, weaning, and child care practices, whether arising from ignorance or taboo, may deprive small children of valuable sources of the vitamin and unnecessarily expose them to health risks. Educational activities need to be based on precise knowledge of food habits, cultural constraints, and value systems in the community and in the families and of available and affordable supplies of vitamin A sources. Whenever possible, planners should seek specialists' advice on the technologies and methodologies most appropriate to the environment.

Interventions at the Individual Family Level

Any intervention will be successful only if it results in the improvement of the vitamin A status of at-risk individuals, usually children of preschool age and women during pregnancy and lactation. It is among these two groups that traditional or cultural practices often influence foods that are thought to be appropriate. Sometimes these practices are not rooted deeply but have developed in response to circumstances that may be modified at the family level. For example, dark green leafy vegetables (DGLV) may be a regular part of the family diet but may not be given to young children or eaten during pregnancy. This may be because the available DGLV contain excessive fiber that is not removed before feeding to children and has become associated with bouts of diarrhea or stomach cramps. In such cases, a family may accept recipes that modify the portion fed to children by sieving to remove fiber. One might also suggest a recipe that contains an alternative source of vitamin A activity more compatible with a child's tastes, such as a sweetened source of red palm or buriti pulp. When inadequate intrafamily distribution occurs, the appropriate intervention is likely to involve education of the family as to the special dietary needs of children and of women during pregnancy and lactation. Suggesting the preparation of a special dish for these vulnerable groups, taking into account cultural and family restraining factors and resources, could be an effective intervention. The intervention approach in any case must be tailored to the reason the maldistribution occurs, and this is likely to vary from one family to another.

Impediments Within Households to Dietary Approaches to Improve Vitamin A Intakes of Children

VI

Food consumption surveys in developing countries indicate a low daily intake by young children of dark green leafy vegetables (DGLV), the richest, usually least expensive, and most widely available source of vitamin A activity. Few studies have been done to assess the factors responsible for this low consumption. Children's diets, however, are usually determined within households by food availability and buying power, food preparation practices, culturally determined food habits, and the educational level of women.

Food Availability

In most tropical regions low-income households eat DGLV to give variety and taste to a monotonous diet. Wild plants and leaves from trees and shrubs (papaya, drumstick, sesbania, and gourds), tuber plants (cassava, sweet potato, and yams), and leguminous plants (peas and beans) are more often the source of leafy greens than are cultivated leafy vegetables (spinach, kangkong, chinese cabbage, and broccoli). The supply at local markets of DGLV, cultivated or wild, is usually meager because of bulk, perishability, and low market value. In rural, infertile, and rain-dependent areas, fresh vegetables may be available only a few months a year.

Foods containing preformed vitamin A, such as milk, cheeses, eggs, and liver, are seldom consumed regularly and in sufficient quantity, mainly because of their high cost. On the other hand, in nonarid lands small fish eaten whole and eels may provide reasonable amounts of vitamin A at an affordable price.

Food Preparation Practices

In poor households, the leafy vegetables that are eaten frequently are those that are commonly not cultivated. Many of them are coarse and fibrous (cassava, sweet potato, cowpea leaves, etc.) or bitter (papaya, yam leaves, etc.) or both. Adults eat these vegetables boiled, steamed, or raw with a hot relish. These vegetables either are considered not suitable for young children or are refused by children because they are bland, bitter, or simply not palatable. This means that young children are offered DGLV only when soft DGLV, such as amaranth or kang-kong, are available, and these are usually available only for a short period of the year. Instituting food preparation practices, such as straining, grinding, preboiling, and so on, that lessen coarse, fibrous constituents could expand the local inventory of vitamin A-containing foods suitable for child feeding.

Cultural Practices

In many societies throughout Latin America, the Middle East, Africa, and Asia, diet plays an important role in the traditional medical systems. In some countries, based on the humoral theory of health and disease, foods are classified as hot and cold. To preserve a balance or to prevent or cure a disease, foods may be avoided or used based on the category to which they belong. This "hot-cold" food system appears to exert influence on food behaviors particularly during pregnancy, lactation, and early childhood. There is, for example, a strong belief that infants should not be given "hot" foods such as mango and tomato. During certain diseases such as measles and sore eyes, "cold" foods (DGLV) should be avoided. In Trengganu, Malaysia, for instance, night blindness is thought to be caused by a threadlike worm that migrates from the gut to the eye after one eats "cold" foods, such as papaya, sweet potato tops, ferns, mustard leaves, and pumpkin. These cultural practices that are deleterious to vitamin A nutriture must be addressed and accommodated in the development of educational materials and mass media communication messages.

Mothers' Nutrition Knowledge and Practices

Ignorance is one of the causes of faulty feeding practices. There has not yet been an assessment of just how important nutrition education is, but in most developing countries, it is a component of nutrition and health programs. At the same time, however, there is often a discrepancy between what mothers know and what they do, frequently out of permissiveness. For example, in some societies young children are never forced to eat what they don't like, and everything is done to keep them from crying. Often, it is not the ignorance of mothers in how to feed their children correctly but the insurmountable limitations of their poverty-bound environment.

Crucial Considerations in Overcoming Impediments

From the limited scientific information that is available and from anecdotes, it is obvious that the dietary approach to combat vitamin A deficiency requires an action program that integrates several crucial components.

1. Beliefs about "good" and "bad" food for young children should be taken into account while encouraging the use of DGLV and red and yellow fruits and tubers, which for certain conditions of the child are considered neutral. Ways of preparation can change "hot" foods to "cold" and vice versa, so that one can circumvent, or work within, beliefs while improving vitamin A intake. (Similar considerations may be needed when attempting to alter the diet of women during pregnancy and lactation.)

2. Availability of DGLV acceptable for and to young children should be ensured throughout the year by horticulture, home gardening, and appropriate methods of preservation. It is essential that DGLV, fruits, and tubers selected for promotion can grow in the local soil and climate without too many costly inputs.

3. Recipes should be developed with mothers to make DGLV more palatable to children (for example, mixed with grated coconut or with a groundnut sauce), easier to digest (preground or strained), and more practical in terms of conserving time, fuel, and money.

4. Planners should emphasize the availability and marketing of beta-carotene sources that are liked by young children, such as yellow pumpkin, squashes, papaya, and mango. It may be better to promote economically inferior fibrous types with low market value to facilitate their home consumption.

5. As a short-term measure, it is worth considering the promotion of processed supplementary foods, preferably those made in the area with locally available ingredients; one example is a flour of cereals, pulses, and air-dried DGLV.

Suggested Readings for Chapters V and VI

ASEAN Subcommittee on Protein (1978) *First seminar/workshop on food habits and in field implementation of nutrition programs.* Manila: ASEAN.

Chen, P.C.V. (1972) Socio-cultural influences on vitamin A deficiency in a rural community. *J. Trop. Med. Hyg.* 75:231–236.

Edmundson, W. (1980) Applied nutritional geography, priorities and praxis. *Soc. Sci. Med.* 14D:133–137.

Epenhuijsen, C.W. van. (1974) *Growing native vegetables in Nigeria.* Rome: FAO.

Hofvander, Y., and Underwood, B.A. (1987) Processed supplementary foods for older infants and young children, with special reference to developing countries. *UN Food and Nutr. Bull.* 9:1–7.

Logan, M.H. (1977) Anthropological research on the hot-cold theory of disease: Some methodological suggestions. *Med. Anthropol.* 1:87–111.

Mandeerson, L. (1984) These are the modern times: Infant feeding practices in peninsular Malaysia. *Soc. Sci. Med.* 18:47–57.

McKigney, J. (1983) Interventions for the prevention of vitamin A deficiency: A summary of experiences. In *Nutrition intervention strategies in national development*. B.A. Underwood, ed. New York: Academic Press.

Oomen, H.A.P.C., and Grubben, G.J.H. (1977) *Tropical leaf vegetables in human nutrition*. Amsterdam: Royal Tropical Institute.

Perisse, J., and Polacci, W. (1980) Geographical distribution and recent changes in world supply of vitamin A. *Food Nutr.* 6:21–27.

Tan, Mely, et al. (1970) *Social and cultural aspects of food patterns and food habits in five rural areas in Indonesia*. Jakarta: LEKNAS-LIPI and Ministry of Health.

Venkataswamy, G., Cobby, M., and Pirie, A. (1979) Rehabilitation of xerophthalmic children: A follow-up study in southern India. *Trop. Geogr. Med.* 31:149–154.

Wandel, M. (1984) Heating and cooling foods in relation to food habits in a southern Sri Lanka community. *Ecol. Food Nutr.* 14:93–104.

Evaluating the Vitamin A Activity (Retinol Equivalent) of Diets

Appendix

Vitamin A Activity from Foods

The vitamin A activity in foods comes from preformed vitamin A, predominantly retinol and retinyl esters, and provitamin A carotenoids. Retinol and its esters have equivalent vitamin A activity and are found in foods of animal origin. Provitamin A carotenoids have variable vitamin A activity depending on their chemical structure. Until recently, vitamin A activity in foods was expressed as international units (IU), where 1 IU preformed vitamin A is equivalent to 0.3 μg of all-trans retinol or, because of the molecular weight difference, to 0.344 μg of retinyl acetate, and 1 IU from provitamin A carotenoids is equivalent to 0.1 μg all-trans retinol. In 1967, a WHO/FAO expert committee decided to abandon the expression of vitamin A value of foods in international units and proposed that vitamin A activity be expressed as the equivalent weight of retinol[1] or retinol equivalents (RE). This change has been accepted internationally. By definition, 1 RE is equal to 1 μg of retinol. In terms of IU, 1 RE is equal to 3.33 IU of retinol and 10 IU of provitamin A carotenoids. These equivalencies are derived from rat bioassays.

Carotenoids occur without exception in photosynthetic tissue. Although animals are incapable of de novo synthesis, they are able to deposit in some tissues the carotenoid pigment as absorbed or with some alteration of the basic structure. Bauernfeind[2] lists 32 carotenoids and apocarotenoids with provitamin A activity; however, the number of known carotenoids now exceeds 500. Table 1 lists representative carotenoids with examples of foods in which they are found. Vitamin A activity has been assigned to various carotenoids on the basis of animal bioassay, in vitro methods using beta-carotene 15,15′dioxygenase with the formation of retinol, or inspection of the molecular structure for presumed activity.

Although the enzymatic conversion of beta-carotene to retinol is theoretically quantitative, physiological

Appendix I, Table 1

Some Carotenoids with Provitamin A Activity Found in Common Food Sources[a]

Carotenoids	Activity %	Occurrence
β-carotene	100	Green plants, vegetables, spinach, carrots, sweet potatoes, squash, tomatoes, green peppers, figs, oranges, cranberries, paprika, grapes, berries, apricots, peaches, prunes, apples, pears, strawberries, watermelons, wheat, corn, pasta products, palm oil, sorghum, algae, lichen, bivalves, fish trout, Tagetes meal, crustaceans
α-carotene	50–54	Green plants, carrots, squash, green peppers, watermelons, potatoes, apples, peaches, oranges, figs, berries, grapes, bananas, pasta, bleached paprika, Tagetes meal, trout, palm oil, chestnuts, corn
γ-carotene	42–50	Carrots, sweet potatoes, tomatoes, corn, algae, some fruits, apricots, watermelons, palm oil, microorganisms
7′8′-dihydro-γ-carotene (β-zeacarotene)	20–40	Corn, tomatoes, yeast, cherries
(β-carotene 5′6′-monoepoxide)	21	Plants, potatoes, red peppers
β-carotene 5′8′-monofuranoxide (mutachrome citroxanthin flavacin)	50	Orange peel, red peppers, algae, tomatoes, sweet potatoes, bleached paprika, cranberries
3-hydroxy-β-carotene (cryptoxanthin)	50–60	Yellow corn, green peppers, pasta, lichens, persimmons, papayas, lemons, oranges, prunes, paprika, apples, apricots, peaches, eggs, strawberries, cranberries, pineapples, poultry, Tagetes meal
4-hydroxy-β-carotene (isocryptoxanthin)	48	Brine shrimp
β-apo-2-carotenal	Active	Citrus fruits
β-apo-8′-carotenal	72	Citrus fruits, green plants, animal tissue, alfalfa meal
β-apo-10-carotenal	Active	Citrus fruits, green plants, alfalfa meal
β-apo-12′-carotenal	120	Alfalfa meal
β-apo-8′-carotenoic acid	Active	Corn, animal tissue
Citranaxanthin	44	Citrus fruits

[a]Adapted from Bauernfeind (Appendix I, note 2). Alternative names are given in parentheses.

inefficiency and variable intestinal absorption from different foods account for reduced overall bioavailability and, therefore, physiological nutritional value. These considerations are taken into account when assigning retinol equivalency (biological activity) to carotenoids. Thus, 1 IU of vitamin A activity from preformed vitamin A (0.3 μg retinol) is equivalent to 1.8 μg of all-trans beta-carotene or 3.6 μg of other provitamin A carotenoids.

In summary,[3]

1 retinol equivalent (RE)
- = 1 μg all-trans retinol
- = 6 μg all-trans beta-carotene
- = 12 μg other provitamin A carotenoids
- = 3.33 IU vitamin activity from retinol
- = 10 IU vitamin activity from provitamin A carotenoids

Although these equivalencies are widely applied, they are not well validated by studies in humans. A great deal of work still is required to assess the biological value of carotenoids in humans. To appropriately evaluate carotenoid biopotency, better information is needed in regard to the products of intestinal carotenoid cleavage, oxidation, and reduction; the transport of these products and intact carotenoids; and the extraintestinal fate of these molecules.

Calculating the Vitamin A Activity of Mixed Diets and Foodstuffs

To calculate the retinol equivalents in a diet or foodstuff from the above definitions of biopotencies, one of the following formulas would be used:[4]

1. When retinol and beta-carotene are given in micrograms (μg), then:

$$RE = \mu g \text{ retinol} + \frac{\mu g \text{ beta-carotene}}{6}$$

Example: A diet contains 500 μg retinol and 1,800 μg beta-carotene:

$$500 + \frac{1{,}800}{6} = 800 \text{ RE}$$

2. When both are given in IU, then:

$$RE = \frac{\text{IU retinol}}{3.33} + \frac{\text{IU beta-carotene}}{10}$$

Example: A diet contains 1,666 IU retinol and 3,000 IU beta-carotene:

$$\frac{1{,}666}{3.33} + \frac{3{,}000}{10} = 800 \text{ RE}$$

3. When beta-carotene and other provitamin A carotenoids are given in micrograms, then:

$$\text{RE} = \frac{\mu\text{g beta-carotene}}{6} + \frac{\mu\text{g other carotenoids}}{12}$$

Example: A 100 g sample of sweet potatoes contains 2,400 μg beta-carotene and 480 μg other carotenoids:

$$\frac{2{,}400}{6} + \frac{480}{12} = 440 \text{ RE}$$

Notes

1. World Health Organization and Food and Agricultural Organization (1967) *Requirements of vitamin A, thiamine, riboflavin and niacin*. WHO Tech. Rept. Ser. 362; FAO Nutr. Meetings Rept. Ser. 41. Geneva: World Health Organization.
2. Bauernfeind, J.C. (1972) Carotenoid vitamin A precursors and analogs in foods and feeds. *J. Agric. Food Chem.* 20:546.
3. Olson, J.A. (1987) Recommended dietary intakes (RDI) of vitamin A in humans. *Am. J. Clin. Nutr.* 45:704–716.
4. Ibid.

Limitations in the Use of Food Composition Tables

Appendix II

Current information on the amount and form of both retinoids and carotenoids in the food supply is of questionable quality and very incomplete. Retinoid data are totally missing from many food groups. Even less is known about the specific carotenoid content of foods. Most food composition tables do not list separately retinol, beta-carotene, and non-beta-carotene provitamin A-active carotenoid contents of even the most common foods. For example, U.S. Department of Agriculture Handbook 8[1] gives only retinol equivalents and international units for all foods without differentiating the proportions from preformed vitamin A and provitamin A forms. The United Kingdom tables[2] report preformed vitamin A as retinol and carotenoids as mixed carotenes on a weight basis (μg/100 g food). The East Asia food table[3] reports retinol on a weight basis but adjusts the carotenoid values for the arbitrary distribution of sources of vitamin A activity in various foods and reports the results as beta-carotene equivalents on a weight basis (μg/100 g food).

The vitamin A data that are currently available in food composition tables allow the proportion of the total vitamin A intake from preformed vitamin A and carotenoids to be estimated. These data are most useful when the risk of overt vitamin A undernutrition or overnutrition is considered. However, information about the intake of specific species of preformed vitamin A and/or carotenoids is not tabulated and cannot be calculated with any certainty from existing food tables.[4]

The accurate determination of provitamin A content depends on the initial lipid extraction from food and the subsequent chromatographic separation and quantification. This can now be accomplished relatively simply by use of high-pressure liquid chromatography (HPLC),[5] but as yet there are limited data on the carotenoid content of foods from this technique. Unfortunately, the standard

Association of Official Analytical Chemists (AOAC) methods for both retinol and carotenoids from which most food composition values have been derived are fraught with problems. The Carr Price colorimetric method for determining retinol content has been shown in a recent collaborative effort to produce a range of values from 0 to 11,880 IU. The AOAC measurement of total vitamin A in foods is even more troublesome, since it separates compounds into only three fractions: preformed vitamin A, carotenes, and xanthophylls. Since it does not separate the various carotene isomers, which have very different biopotency, accurate calculations of vitamin A activity cannot be made. For example, including the nonactive carotenoid lycopene with other carotenes of tomatoes results in a five- to-tenfold overestimation of vitamin A activity. This same overestimation has been shown for orange juice and is undoubtedly true for other fruits and vegetables.

Degradative changes of provitamin A compounds in foods during processing, cooking, and storage result in the lowering of vitamin A activity.[6] In general, the carotenoids are destroyed or altered by acids, particularly in the presence of light. Sun drying and extended cooking are especially destructive processing steps, whereas cooking and canning generally result in only slight losses.[7] Mashing and grinding, which increase exposure to atmospheric oxygen and degradative enzymes, also are destructive. A great deal more research has to be done on the stability and effects of storage, processing, and cooking on the oxidation and isomerization of retinol and individual carotenoids in foods. This is particularly important when assessing the biopotency of foods cooked under primitive conditions usual to populations where vitamin A deficiency is common. Because of these limitations, one must be cautious in the interpretation of vitamin A intake data from currently available food composition tables as a reliable quantitative estimate of vitamin A intake.

Notes

1. U.S. Department of Agriculture, Agricultural Research Service (1976–84) *Composition of foods: Raw, processed, prepared.* Agricultural handbooks, 8–1 to 8–13 (revisions to Handbook 8). Washington, D.C.: Government Printing Office.
2. Paul, A.A., and Southgate, D.A.T. (1978) *McCance and Widdowsons's "The composition of foods."* 4th rev. ed. London: Her Majesty's Stationery Office.
3. Weu Leung, W.T., et al. (1972) *Food composition table for use in East Asia.* Rome: FAO.
4. Beecher, G. (1984) Vitamin A and cancer prevention conference. *J. Natl. Cancer Inst.* 73:1397–1404.

5. Simpson, K.L., Tsou, S.T.C., and Chichester, C.O. (1987) *Biochemical methodology for the assessment of carotenes*. Washington, D.C.: IVACG.
6. Simpson, K.L., and Chichester, C.O. (1981) Metabolism and nutritional significance of carotenoids. *Ann. Rev. Nutr.* 1:351–374.
7. Sweeny, J.P., and Marsh, A.C. (1973) Liver storage of vitamin A in rats fed carotene stereoisomers. *J. Nutr.* 103:20–25.

Illustration of the Use of the Simplified Dietary Approach: Pilot Tests in Pahou, Benin, and Madura, Indonesia[a]

Appendix III

Benin is an example of a country where little or no dietary information is available (i.e., no secondary information is available), while Madura, Indonesia, is an area where nutrition surveys are conducted at regular intervals (i.e., secondary information is available). The time involved to develop the food composition data banks and the dietary questionnaires was therefore longer in Benin (Tables 1 and 2).

In addition, the types of dishes and the dietary patterns are different in the two locations. In Pahou, Benin, the staple foods are eaten with soups (sauce) in a variety of mixed food compositions. The average retinol equivalent (RE) content of each type of soup (sauce) had to be determined (Table 3) as well as the portion size of each serving per child (Table 4). An additional source of RE in this community was snacks, which usually contain appreciable amounts of RE and are regularly eaten by children. The composition of these snacks as well as the RE content had to be determined (Table 5).

In Madura, Indonesia, servings of the staple food can be quantified in household measures (scoops). Likewise the foods in the side dishes can be served separately and portion size can also be determined either in household measures or in specific quantities, such as the size of a matchbox (Table 6).

The forms used to calculate the consumption index (CI) in Pahou and Madura are shown in Tables 7 and 8 and the dietary history questionnaires in Tables 9 and 10.

The experience from these two locations suggests that the dietary assessment proposed by IVACG is feasible if a nutritionist or another professional with nutritional expertise is available. Although field workers who have finished primary school can be trained for the interviews and calculation of CI and usual pattern of food consumption (UPF) scores, preference should be given to persons with some years of secondary schooling.

[a]Pilot tests were conducted under the guidance of Dr. Jane A. Kusin of the Royal Tropical Institute.

Appendix III, Table 1

Outline and Time Schedule for the Development of a Food Composition Data Bank and Dietary Questionnaires: Pahou, Benin

Steps	Sources	Time Involved (Weeks)
1. Food availability and 2. Usual dietary patterns	Rapid Rural Survey (RRS) and data analysis	6
3. Standard recipes and 4. Usual portion sizes	Special survey	10
5. Food composition data bank/scoring	Desk work	1
6. Preparation of questionnaires	Desk work	1
7. Training of field workers/adjustment of questionnaires	Classroom and fieldwork	6
8. Interview of 100 mothers	Fieldwork	2 (steps 8–9)
9. Calculations of CI + UPF	Desk work	
Total		26

Note: Personnel required to complete steps 1–9: steps 1–7, nutritionist and five field workers; steps 8–9, field workers. CI = consumption index; UPF = usual pattern of food consumption.

Appendix III, Table 2

Outline and Time Schedule for the Development of a Food Composition Data Bank and Dietary Questionnaires: Madura, Indonesia

Steps	Sources	Time Involved (Weeks)
1. Food availability and 2. Usual dietary patterns	Reports and publications, cross-checked by group discussions in villages	1
3. Standard recipes and 4. Usual portion sizes	Special survey	1
5. Food composition data bank/scoring	Desk work	1
6. Preparation of questionnaires	Desk work	1
7. Training of field workers/adjustment of questionnaires	Classroom and fieldwork	6
8. Interview of 100 mothers	Fieldwork	1 (steps 8–9)
9. Calculations of CI + UPF	Desk work	
Total		11

Note: Personnel required to complete steps 1–9: steps 1, 2, and 5, nutritionist; steps 3, 4, 6, and 7, nutritionist and five field workers; steps 8–9, five field workers and nutritionist. CI = consumption index; UPF = usual pattern of food consumption.

Appendix III, Table 3

Composition and Vitamin A Content of Some Types of Sauces: Pahou, Benin

	Ingredients			μg Vitamin A/100g (Vitamin A Score in Parentheses)		
Type of Sauce	Type	Mean Amount (g) (SD in Parentheses)	RE Vitamin A (μg)	Without Palm Oil and DGLV[a]	With DGLV[b] (20 g = 120 RE Vitamin A)	With Palm Oil/Palm Nuts[c] (10–15 g = 500–750 RE Vitamin A)
Sauce with smoked or fried fish (n = 49)[d]	Fish	12 (4)	4	16 (1)	136 (3)	516 (5)
	Tomatoes	12 (5)	10			
	Onions	2 (2)	—			
	Peppers	2 (2)	2			
Sauce with fresh fish (n = 30)	Fish	26 (12)	5	38 (1)	158 (3)	538 (5)
	Tomatoes	12 (8)	10			
	Tomato puree	4 (3)	19			
	Onions	3 (2)	—			
	Peppers	3 (2)	4			
Sauce with dried fish (n = 24)	Fish	4 (3)	1	9 (1)	129 (3)	509 (5)
	Tomatoes	7 (4)	6			
	Onions	1 (1)	—			
	Peppers	3 (2)	2			
Sauce with meat (goat, chicken, beef, etc.) (n = 19)	Meat	29 (16)	6	43 (1)	163 (3)	543 (5)
	Tomatoes	11 (4)	9			
	Tomato puree	5 (3)	24			
	Onions	3 (2)	—			
	Peppers	3 (2)	4			
Monyo (crushed vegetables)	Tomatoes	40	32	56 (3)	—	—
	Peppers	20	24			
	Onions	15	—			

[a]Dark green leafy vegetables.
[b]About half of the sauces are prepared with dark green leafy vegetables. Except for *Talinum triangulare* (300 μg RE/100 g), the carotene content of the vegetables used varies from 550 to 700 μg RE/100 g.
[c]Five out of six sauces are prepared with red palm oil or palm nuts. Other types of oil used are coconut oil and groundnut oil.
[d]Number of samples analyzed.

Appendix III, Table 4
Food Composition Data Bank: Pahou, Benin

Local Food	Serving Size			RE (μg/100 g)	Vitamin Score
Staple Foods (basic unit, ¼ cup [50 g])					
Pâte rouge	¼ cup			106	
RE	53				L
Piron rouge	¼ cup			108	
RE	54				L
Sweet potato, medium yellow	Small 30 g	Medium 50 g	Large 100 g	300	
RE	90	150	300		M
Fresh maize	Small 30 g	Medium 50 g	Large 100 g	60	
RE	18	30	60		L
Sauces[b] (basic unit, ¼ cup [60 g])					
Sauce with palm oil or palm nuts	¼ cup			500–750	
RE	300–450				H
Sauce with fish or meat without DGLV[c]	¼ cup			16–57	
RE	10–34				L
Monyo (crushed vegetables)	¼ cup			130	
RE	78				M
Sauce with fish or meat with DGLV	¼ cup			150–205	
RE	90–123				M
Fruit (basic unit, 1 medium-size piece)					
Banana	40 g			20	
RE	8				L
Orange	60 g			80	
RE	48				L
Sapotille	40 g			50	
RE	20				L
Tangerine	40 g			120	
RE	48				L
Mango	100 g			400	
RE	400				H
Cashewfruit	40 g			300	
RE	120				M
Pawpaw	¼ = 100 g			300	
RE	300				H

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Appendix III, Table 4 *(continued)*

Local Food	Serving Size	RE (μg/100 g)	Vitamin A Score[a]
Snacks[d]	(basic unit, 1 medium-size portion)		
Bean snack	20 g		
RE	172	860	*M*
Groundnut stick	15 g		
RE	202	1,350	*M*
Fried cassava cookies/snack	20–25 g		
RE	225–305	900–1,500	*H*
Maize ball	25 g		
RE	250	1,000	*H*
Maize bean ball	110 g		
RE	1,110	1,000	*H*
Egg	40 g		
RE	120	300	*M*

[a]Vitamin A score is based on the level of RE in a basic unit per serving: *L* (low) = less than 50 μg; *M* (moderate) = 50–250 μg; *H* (high) = greater than 250 μg.

[b]For sauces, the average consumption per type was obtained from 15 to 50 recipes. Types were regrouped into four categories, based on vitamin A content. See Table 3 in this appendix for composition and RE content per type of sauce.

[c]Dark green leafy vegetables.

[d]The composition of snacks was based on three to five recipes per type, collected from snack vendors. See Table 5 in this appendix for average composition and RE content.

Appendix III, Table 5

Composition and Vitamin A Content of Snacks: Pahou, Benin

Name and Description	Ingredients: Type	Ingredients: Amount (g/100 g)	Ingredients: RE (μg/100 g)	Total RE in Snack (μg/100 g)
Gâteau d'haricot (bean snack)	Bean flour	47	—	861
	Palm oil	17	850	
	Peppers	9	11	
	Onions	5	—	
Klu-klui (groundnut stick)	Groundnuts	50	—	1,352
	Palm oil	27	1,350	
	Peppers	2	2	
	Maize flour	10	—	
Gbêli (fried cassava snack)	Cassavas	72	7	1,509
	Palm oil	30	1,500	
	Peppers	2	2	
Wohounkpa (cassava cookies)	Cassava flour	78	—	902
	Palm oil	18	900	
	Peppers	2	2	
	Onions	2	—	
Kpôme-klé-klé (maize balls)	Maize flour	69	—	1,004
	Palm oil	20	1,000	
	Peppers	3	4	
	Onions	3	—	
Abla (maize bean balls)	Dried beans	18	—	1,002
	Maize flour	20	—	
	Palm oil	20	1,000	
	Peppers	2	2	
	Onions	2	—	

Appendix III, Table 6

Food Composition Data Bank: Madura, Indonesia

Local Food	Serving Size[a] Small	Medium	Large	RE (μg/100 g)	Vitamin A Score[b]
Staple Foods					
Yellow maize	1 sc (25 g)	2 sc (50 g)	4 sc (100 g)	135	
RE	34	68	135		*L*
Sweet potato, light yellow	½ p (50 g)	1 p (100 g)	2 p (200 g)	18	
RE	9	18	36		*L*
Sweet potato, deep yellow	½ (50 g)	1 p (100 g)	2 p (200 g)	840	
RE	420	840	1,680		*H*
Beans					
Kacang ijo, tempe, lamtoro	1 tbsp (25 g)	2 tbsp (50 g)	4 tbsp (100 g)	15–28	
RE	4–7	8–14	15–28		*L*
Eggs/Meat/Fish					
Eggs, chicken or duck	½ (25 g)	1 (50 g)	2 (100 g)	530	
RE	132	265	530		*M*
Chicken	1 p (25 g)	2 p (50 g)	4 p (100 g)	240	
RE	60	120	240		*M*
Liver	1 p (10 g)	2 p (20 g)	4 p (40 g)	6,000	
RE	600	1,200	2,400		*H*
Fresh fish (ikan pindang, bandang udang, kerang)	10 small or 1 mb (10 g)	20 small or 2 mb (20 g)	40 small or 4 mb (40 g)	20–60	
RE	2–6	4–12	8–24		*L*
Eel (ikan lele belut)	1 mb (10 g)	2 mb (20 g)	4 mb (40 g)	800	
RE	80	160	320		*M*
Vegetables					
Dark green leafy vegetables (bayam, kangkung, singkong)	1 tbsp (25 g)	2 tbsp (50 g)	4 tbsp (100 g)	2,200	
RE	550	1,100	2,200		*H*
Medium dark green leafy vegetables (daun kuning)	1 tbsp (25 g)	2 tbsp (50 g)	4 tbsp (100 g)	350	
RE	87	175	350		*M*

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Appendix III, Table 6 *(continued)*

Local Food	Serving Size[a] Small	Medium	Large	RE (μg/100 g)	Vitamin A Score[b]
Beans, gourd, young pawpaw	1 tbsp (25 g)	2 tbsp (50 g)	4 tbsp (100 g)	30	
RE	8	15	30		*L*
Fruit					
Mango, ripe	½ (25 g)	1 (50 g)	2 (100 g)	940	
RE	235	470	940		*M*
Pawpaw, ripe	2 mb (25 g)	4 mb (50 g)	8 mb (100 g)	180	
RE	45	90	180		*L*
Jackfuit, ripe	1 p (50 g)	2 p (100 g)	4 p (200 g)	165	
RE	82	165	330		*M*
Banana, ripe	1 (50 g)	2 (100 g)	4 (200 g)	120	
RE	60	120	240		*M*
Guava ("blimbing")	1 (25 g)	2 (50 g)	4 (100 g)	20–80	
RE	5–20	10–40	20–80		*L*
Mango, unripe	½ (25 g)	1 (50 g)	2 (100 g)	60	
RE	15	30	60		*L*

[a]Vitamin A score is based on the level of RE in a basic unit per serving: *L* (low) = less than 50 μg; *M* (moderate) = 50–250 μg; *H* (high) = greater than 250 μg.
[b]Household measures used: sc = scoop, p = piece, mb = matchbox-size piece.

Appendix III, Table 7

Calculation of Consumption Index: Pahou, Benin

Fiche 2: Consommation Réalisée des Produits Contenant Vitamine A

Nom: ______________________ Date d'enquête: ______________________

Village: ______________________ Nom enquêteur: ______________________

Numéro maison: ______________________

Produit	Score de Vitamine A (*A*)	Quantité Consommé (in Household Measures)	Facteur de Multiplication (No. of Basic Units) (*B*)	Unités de Vitamine A (CI) (*A* × *B*)
Produits de Base				
Piron rouge	*L*			
Pâte rouge	*L*			
Maïs frais	*L*			
Patate douce	*M*			
Sauces				
Sans légumes feuilles	*L*			
Monyo	*M*			
Avec légumes feuilles	*M*			
Fruits				
Banane	*L*			
Orange	*L*			
Sapotille	*L*			
Mandarine	*L*			
Mangue	*H*			
Pomme d'acajou	*M*			
Papaye	*H*			
Casse-croûtes, Divers				
Gâteau d'haricot	*M*			
Kluk-lui	*M*			
Tale-tale	*M*			
Gbêli, wohounkpa	*H*			
Kpôme-klé-klé	*H*			
Abla	*H*			
Oeuf	*H*			

Score pour la taille de la portion (= facteur de multiplication):

mesuré avec le bol gradué: ¼ cup = 1, ½ cup = 2, 1 cup = 4.

Unités (fruits ou casse-croûtes) 1 (moyen) = 1; si la femme dit que le fruit était petit = ½; grand = 2.

Appendix III, Table 8

Calculation of Consumption Index: Madura, Indonesia, Consumption Inde (24-Hour Recall)

Foods Consumed Yesterday	Vitamin A Score	Serving Size			Consumpt Index (C
		Small	Medium	Large	
Staple					
Jagung	*L*				
Ubi jalar putih	*L*				
Ubi jalar kuning	*H*				
Beans					
Kacang ijo, tempe lamtoro, peti ci na	*L*				
Egg/Meat/Fish					
Telur	*M*				
Daging ayam	*M*				
Hati	*H*				
Ikan pindang, bandeng, udang	*L*				
Kerang, ikan lele, belut	*M*				
Vegetables					
Kacang panjang, buncis, pepaya	*L*				
Muda, labu kuning, tomat, daun	*M*				
Medium dark daun, dark green bayam, ubi jalar singkong, kelor	*H*				
Fruits					
Jambu biji blimbing	*L*				
Mangga muda, papaya matang, pisang, nangka	*M*				
Matang mangga matang	*H*				
		Total CI			

Breast-fed: yes/no

Appendix III, Table 9

Dietary History of Children Ages One to Five: Pahou, Benin

How often does the child usually eat one of the following food items?

Season ______________________

Food Item	Frequency of Consumption		
High vitamin A score	Daily × 150[a]	Weekly × 60[a]	Monthly × 15[a]
Sauce avec l'huile rouge ou noix de palme			
Gbêli wohounkpa abla, kpôme-klé-klé			
Mangue, papaye			
Moderate vitamin A score	Daily × 90	Weekly × 36	Monthly × 9
Sauce avec légumes feuilles			
Monyo			
Patate douce			
Gâteau d'haricot, klu-klui, tale-tale			
Oeuf			
Pomme d'acajou			
Low vitamin A score	Daily × 30	Weekly × 12	Monthly × 3
Sauce sans l'huile rouge et sans légumes feuilles			
Pâte rouge, piron rouge			
Maïs frais			
Banane, sapotille, orange, mandarine			

[a]Numbers represent weighting factors in calculations of UPF scores.

Appendix III, Table 10

Dietary History of Children Ages One to Five: Madura, Indonesia

How often does the child usually eat one of the following food items?

Season ____________________

Food Item	Frequency of Consumption		
High vitamin A score	Daily × 150[a]	Weekly × 60[a]	Monthly × 15[a]
Dark green leafy vegetables: bayam, kangkung, singkong, kelor, daun ubi jalar			
Hati (liver)			
Mangga masak (ripe mango)			
Ubi jalar kuning (sweet potato, deep yellow)			
Moderate vitamin A score	Daily × 90	Weekly × 36	Monthly × 9
Telur ayam, itik (eggs)			
Daging, ayam (goat, chicken)			
Ikan lele, belut (eel)			
Medium green leafy vegetables			
Labu kuning, tomat, daun			
Papaya, pisang, nangka masak (ripe pawpaw, banana, jackfruit)			
Mangga muda (unripe mango)			
Low vitamin A score	Daily × 30	Weekly × 12	Monthly × 3
Jagung kuning (yellow maize)			
Ubi jalar putik (sweet potato, white)			
Ikan pindang, bandang			
Udang, segar (fish)			
Kacang ijo, tolo, koro, tempe (dried beans)			
Light green leafy vegetables: kacang panjang, buncis, papaya muda			
Blimbing/jambubiji			

[a]Numbers represent weighting factors in calculations of UPF scores.