ABSTRACT

"THE NUTRIENT DATABASE: LABELLING AND PRODUCT DEVELOPMENT*

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The use of a nutrient databank in the food industry has gone far beyond the monitoring and labelling functions. Americans now consume more than half their diet as processed foods rather than fresh produce. The fact that the incidence of obesity among Americans is on the increase, contrasted by a decreasing trend in total caloric intake, has created a marketplace for more nutrient-dense, calorie-reduced foods. To meet this consuming need, the food industry must give nutritional criteria a prominent role in the product development process and optimize food products to meet the nutritional needs of Americans while keeping calorie levels low enough to match our less active lifestyles. Naturally, we are not willing to give up sensory qualities, low cost, and convenience, and the problem suddenly becomes so complex that a computer is needed to keep track of the multiple criteria. Using a comprehensive nutrient databank and a variety of software, we can now have the computer do the tedious work of determining the combinations and levels of ingredients needed to maximize nutritional value while minimizing calories and costs.

To be most efficient, the system must integrate the databases containing the various types of information needed, to enable simultaneous consideration of the actual eating habits, health status and food preferences of the consumers as well as the sensory, cost and nutritional characteristics of the potential ingredients.

This poses a challenge both to the expertise of the software creators and to the imagination and daring of the food technologists and nutritionists as well. The original role of the nutritionist in diet evaluation and menu planning is now being expanded by the need to understand computer languages and computer systems.

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Nutrient databases have become more important in the food industry since the creation of the nutrient labelling regulations in 1973. Whereas the original purpose for nutritional labelling was to help prevent deficiencies and promote awareness of ingredients, current concerns center on substances to avoid such as fat, cholesterol, sugar, and salt. Thus, industry has the government, health professionals, and the consumers to consider, and America's interest in and pursuit of "good nutrition" has never been greater. Today the low-calorie, nutrient-dense foods represent one of the fastest growing markets in the country. This has put tremendous pressure on the food industry to optimize its product development process through the use of much more comprehensive and innovative nutrient database systems.

My presentation today will focus on the general characteristics of the databases used in a food company, as well as how they function as a vital tool in many areas of the company, particularly in the labelling, product research and development functions.

There are two main types of nutrient databases commonly used by the food industry; an internal database, covering company products, and an "external" nutrient database, containing data on other food items (Fig. 1). The internal monitoring database contains nutrient data on the company's products based on laboratory analyses. The label values are derived from the analytical data and stored in a labelling database.

Federal regulations state that complete nutritional labelling is triggered by the addition of nutrients during processing or by any specific nutrition-oriented claims on the label or in advertising. When labelling is required, values for calories and ten nutrients: protein, fat and carbohydrate; vitamins A, C, thiamin, riboflavin, niacin; iron and calcium must be listed using the units shown, and as a percent of the U.S. Recommended Daily Allowance. Percentages stated must be based on the U.S. Recommended Daily Allowance, and expressed on a per serving basis (Table 1). Values for approximately 15 other nutrients (vitamins B6 and B12, phosphorous, magnesium, zinc, copper, biotin, and pantothenic acid, cholesterol, fiber, sugar) are optional.

Under current regulations, an optional nutrient, such as phosphorous, can be listed without triggering full nutritional labelling. However, if any required nutrient is listed, they all must be.

As research continues to point out the importance of specific nutrients in relation to the health concerns of today's population, the demand for increased labelling grows. I'm sure most of you are aware of the proposal currently before the FDA requesting mandatory sodium labelling, and I'm sure others will follow. Thus, while the minimum number of nutrients of concern in the labelling process is anywhere from 10 to 25, this number is increasing constantly.

At Campbell's we currently have data for about 1,000 products, and this data must be monitored several times a year, by performing laboratory analyses on representative samples from each plant. This amounts to at least 30,000 individual analyses done annually in our lab, and a large and constantly changing database of analytical values.

The monitoring database contains all the information needed to calculate the label values (Fig. 2). The procedures used are defined by the FDA in the Code of Federal Regulations (or CFR). The computer performs calculations of percent U.S. RDA and estimated Protein Efficiency Ratio, or PER, which is needed to calculate the percent RDA of protein. Statistical tests are done to set the label value.

The label values are then stored in a separate file and updated periodically.

While these regulations help to simplify and standardize the nutritional information presented on a label, it is the continually updated database which will inevitably be a company's primary resource for product data for use in education, advertising, and in product research and development (Fig. 3).

As accurate and complete as this dynamic database is, however, another source of food composition data, which I've called the external database, is needed for several reasons.

When a product reformulation is being considered, a source of nutrient data is needed to estimate the nutritional composition of the new product without the time and expense of laboratory analyses. This calculated value can then be compared with the current label, to see if label changes would be necessary. It would also be compared with nutritional standards to ensure maintenance or improvement of the nutritional quality of the product. This information would then be incorporated into a cost/benefit analysis to help plan the reformulation project.

A similar process is followed in the case of new products, and I'll be discussing this in more detail in a few minutes.

An external source of data is also useful in assessing how well a product compares with similar products available to the consumer--either homemade, restaurant or manufactured products. This can be used both as a guide in product development or in the marketing of existing products.

Thus, a source of external food composition data is needed, but, as this database is generally only updated once a year, to be most effective it must be linked to the internal database which will always contain more accurate data on company products. In order to do this, the database system must be flexible enough to enable this merging to occur as well as allowing easy access for frequent updating.

The "external" database must meet a number of criteria in order to be most useful to a food company. Use of the database in the research and development of new products and in advertising and product promotions imposes certain requirements different from those which may be needed for other purposes such as diet evaluation. I would now like to describe these requirements and explain why each is important in the research and development process.

The food items should include not only ingredients found in the kitchen such as raw egg white, but also commercial product ingredients such as "powdered egg white" (Table 2). Currently, most data banks have been developed for diet evaluation or menu planning, and commercial ingredients have largely been ignored.

In addition to raw ingredients, foods packaged and prepared in a variety of ways should be included, to enable imitating the effects of processing as much as possible.

The database should also include brand name items, recipes from prominent cookbooks, and restaurant items in order to insure that the nutritional quality of the current or proposed product at least equals that of similar products. Some companies are particularly interested in certain ethnic or international markets, and the database should be assessed with that in mind as well.

The nutrients listed in the database should include at least the 25 listed previously in relation to food labelling and for which there are RDA's set by the National Academy of Sciences (Table 3). Also, nutrients which may be of concern to specific target populations should be included. These might include other minerals and electrolytes such as flouride, selenium, and potassium. Amino acid data is also useful to enable estimation of the protein quality of a proposed product.

There are a number of other food components which may also be of interest in product development. These include components which certain groups may need to avoid such as allergens like lactose and gluten, as well as food characteristics such as digestibility or protein efficiency ratio. Where accurate quantitative data is difficult or impossible to obtain, a flagging system would be very useful for keeping track of this type of information during the product development process.

Another aspect of the database critical for any purpose but particularly important in product development, is the amount of missing and assumed data. When designing a product based on nutritional criteria, the relevant nutrient data must be complete.

It is important that missing data be identified as different from assumed or true zero values.

Nutrient data should be available for both 100g units or typical serving size, and the values used for converting from a volume quantity such as a cup, or a typical serving to equivalent weights must be listed and documented. We have found that this conversion is a common source of error In nutrient composition calculations, partly due to imprecise definitions of an average serving, for instance, and partly due to assumptions made in the factors used to convert between volume and weight.

In addition, the source of each nutrient value should be identified. The reference should be traceable and include the method of analysis. This is particularly important when developing promotional and advertising material as it is subject to the scrutiny of not only the corporate scientists and lawyers, but the legal departments of the advertising agency and the media as well.

Another aspect important in product development is the coding system used. The food codes should enable accessing the data by food group such as "meats" as well as food type such as "beef". This is useful in the early phase of product development where one may wish to compare potential ingredients based on nutrient composition. It would also be useful to have a code indicating the type of packaging and the state and method of preparation. A typical request during the product development process might be to provide a list of cooked roast beef items with more than 10% of the RDA of selected nutrients, per one ounce serving. With an efficient coding system and the appropriate software, this task is very easy to perform.

The software needed for maintenance and utilization of the database is often available for purchase. Because of the potential problems with computer systems compatibility, however, we have found it more efficient to develop much of our own software designed specifically for our own needs. This approach requires a programmer available on a continuous basis, at least while the system is being developed. The maintenance software must create an interface between the nutrient database and the internal monitoring database to insure that the most accurate data possible is used. One may also want to consider interfacing the nutrient database with other types of food data used in product development, such as the ingredient cost file. Be aware, however, that these other datafiles will have been established years ago with rigid designs geared for a specific purpose. Extensive support may be required from the programmers and computer systems analysts to develop these interfaces.

The applications software needed for product development covers a wide variety of areas, from simple nutritional calculations to complex statistical analyses, and involves virtually every area of the company. Some types of applications software can be purchased or rented, such as SAS or SPSS, and some will have to be developed for your particular needs. Computer science expertise will be needed in either case, however, to link the software with the databases and assist in the development of an efficient system.

Once developed, however, the benefits will be felt by the entire company in terms of efficiency and innovation.

The traditional product development process began with a concept initiated, most often, from the marketing unit (Fig. 4). The concept was then refined through discussions between the marketing personnel and the food technologists. The refined concept would be tested at consumer focus groups to determine the level of consumer interest. Prototypes would then be produced in the test kitchens and evaluated for sensory, cost, and engineering considerations. Revisions would be suggested, and the process would be repeated as many times as necessary. When the product was good enough to satisfy the internal inspections, it would be sent to test markets to determine consumer acceptance. When the product was finally ready for large-scale marketing, the product would be fully analyzed for nutritional labelling. Only then would the nutritionists be consulted to determine what nutritional strengths the product might have for use in advertising, promotions, and other consumer communications.

Two main factors have made this traditional approach inappropriate. First is the extensive progress made in the last decade in delineating the complex relationships between diet and health. Second is the high level of consumer awareness of the nutritional Quality of their diets. Thus, the current goal at Campbell's is to include nutritional evaluation right at the beginning of the product development process. In addition, nutritional criteria are set for new products based on the nutritional requirements of the proposed product users. The nutrient database has become a powerful and indispensable tool in the implementation of these goals.

I would now like to show you exactly how this is done, beginning with the first phase, or the development of a new product concept. While this concept can originate from several sources, the nutrient database can be used here in conjunction with the traditional methods to help identify and focus in on new product opportunities (Fig. 5).

The nutrient database enables a company to analyze diet surveys performed by the company or by others. The critical questions asked constantly by the market researchers, such as:

- "What kind of people eat or do not eat product A?" can be augmented by

- "How nutritionally healthy are their diets?"

- "Where does product A fit in?"

Say, for instance, it is found that the product user's diet was low in calcium, and that product A was not contributing a significant amount of that nutrient. Reformulations could be undertaken to increase the amount of calcium in product A, or to develop a complementary or substitute product which would provide the calcium needed. Naturally, there are many other factors that must be considered as well before such a project is undertaken. Other types of information can be obtained from the survey, such as demographic, anthropometric, biochemical, food preference and meal pattern data. All of this information can be used to help develop a product which fits the lifestyle and nutritional health characteristics of the proposed product user. Conversely, the database can be used to evaluate the product concept in terms of its potential impact on the user's diet and nutritional health. This is an important consideration in deciding which concepts warrant further development and which do not.

This nutritional evaluation can also be used to refine a concept into a high quality, saleable product. Nutritional criteria are set up, based on the U.S. Dietary Guidelines and the NAS-NRC recommended daily allowances for the target population (Table 4). In this example, based on typical guidelines for a frozen dinner, levels were set for calories, sodium, and specific nutrients as shown. Usually from this point many prototypes are developed, based on food preferences and technical considerations. One example is shown here and contains chicken, chicken broth, pineapple, green beans, rice and a cookie (Table 5). This information would be fed into the computer to calculate the nutritional composition of the meal. We then check to see how well it compares with the criteria stated previously concerning the levels of calories and nutrients.

We simultaneously calculate the percent U.S. RDA's, and check these against our criteria as well. Here, we achieved the 30% goal for only 4 nutrients, and had more calories from fat and protein than was desired. We also monitor the RDA values for the other age groups, to see that the product could be used by anyone without adverse effects. All this can be done in a matter of minutes, compared to the long hours of manual calculations or laboratory analyses required otherwise.

With the appropriate software, the database also helps us to reformulate the product by providing alternative ingredients or proportions that will help meet the criteria specified (Fig. 6). The new product continues through the sequence of inspections and reformulations as before, with the addition of a nutritional evaluation at each step, to be sure that the nutritional standards are maintained.

Only when the product is ready for the test market would it be analyzed by the laboratory.

Another type of product development research involving the nutrient database is in the area of enrichment and fortification. Whereas specific nutritional deficiencies are relatively rare in this country, concern has recently been expressed regarding iron and calcium status, particularly among women. The impact of fortifying or enriching a product can be assessed by analyzing internal or external diet survey data with and without the fortified product. The database allows us to see the effect on the user's total diet and predict positive or negative interactions. In view of the current widespread use of supplements, and the concern about nutrient excesses, this type of evaluation has become even more important.

Overall, what we have a picture of is a multidimensional database, integrating many types of data for a variety of purposes (Fig. 7). The research and development applications pose some specific problems and impose specific criteria on the system. I hope I have given you some insight into both the benefits and potential problems associated with the use of a nutrient database for enhancing the product development process in a food company.

Figure 1.

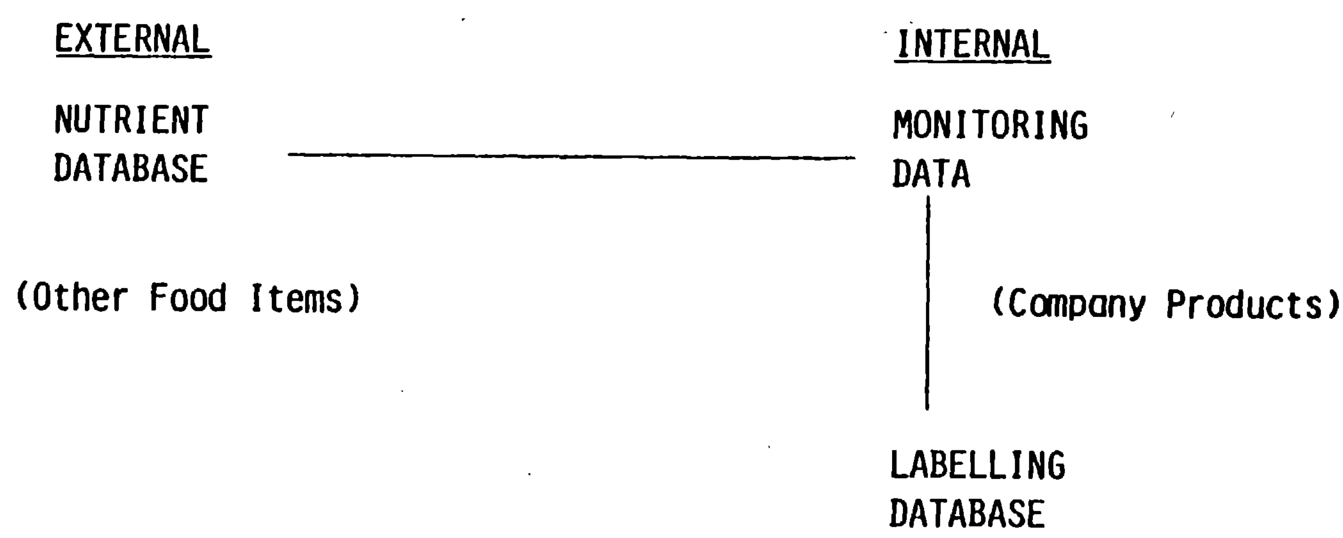

EXTERNAL
NUTRIENT DATABASE
(Other Food Items)
INTERNAL
MONITORING DATA
(Company Products)
LABELLING DATABASE

TABLE 1.

LABELLED NUTRIENTS

	Required	Units/Serving
1.	Calories	Kcal
2.	Protein	g, % USRDA
3.	Fat	g
4.	Carbohydrate	g
5.	Vitamin A	IU, % USRDA
6.	Vitamin C	Mg, % USRDA
7.	Thiamine	Mg, % USRDA
8.	Riboflavin	Mg, % USRDA
9.	Niacin	Mg, % USRDA
10.	Calcium	g, % USRDA
11.	Iron	Mg, % USRDA

FIGURE 2.

INTERNAL DATABASE

Monitoring Data

- Product No.
- Laboratory Means
- Standard Error
- Sample Size
- Plant No.

--Continuously Updated

Software

- CFR Regulations
- % USRDA
- PER
- Confidence Level

Lins

- Product No.
- Current Label
- Proposed Label
- Risk Factor

--Updated Quarterly/Annually

FIGURE 3.

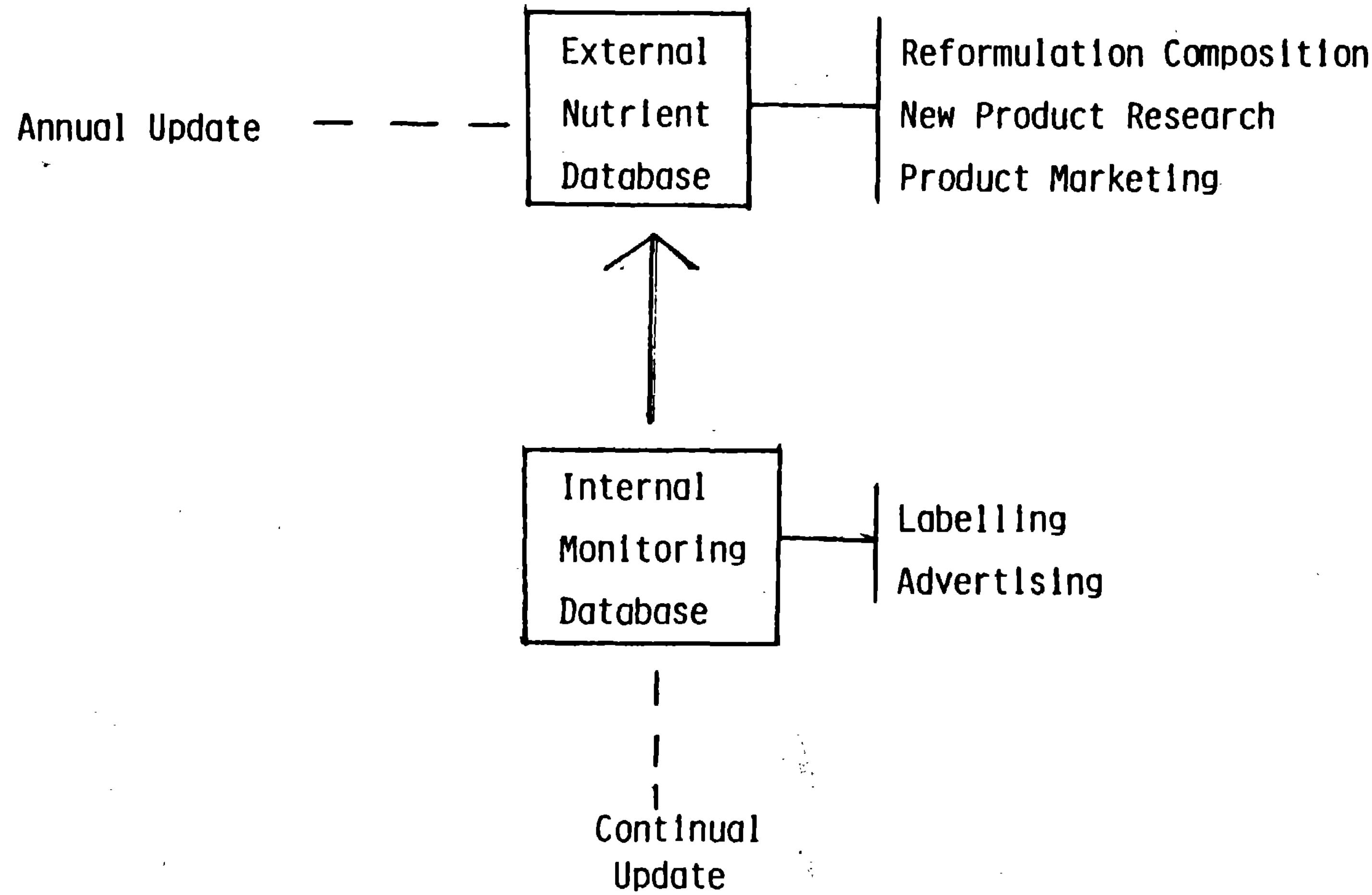

Annual Update
External
Nutrient
Database
Reformulation Composition
New Product Research
Product Marketing
Internal
Monitoring
Database
Labelling
Advertising
Continual
Update

TABLE 2.

EXTERNAL DATABASE

FOOD ITEMS

1. Raw Ingredients
   - Retail, i.e. raw egg white
   - Wholesale (Commercial)
     i.e. powdered egg white,
     stabilized

2. Cooked Foods
   - Boiled
   - Broiled
   - Steamed
   - Sliced
   - Mashed
   - Whole

3. Prepared Foods
   - Brand Names
   - Recipes
   - Restaurant Items

TABLE 3.

EXTERNAL DATABASE

NUTRIENTS

1. Labelled Nutrients (10-25)
2. Other Nutrients
   - Trace Minerals
   - Electrolytes
   - Amino Acids

OTHER COMPONENTS AND CHARACTERISTICS

1. Caffeine
2. Allergens - Lactose, Gluten
3. Digestibility, PER

FIGURE 4.

TRADITIONAL PRODUCT DEVELOPMENT PROTOCOL

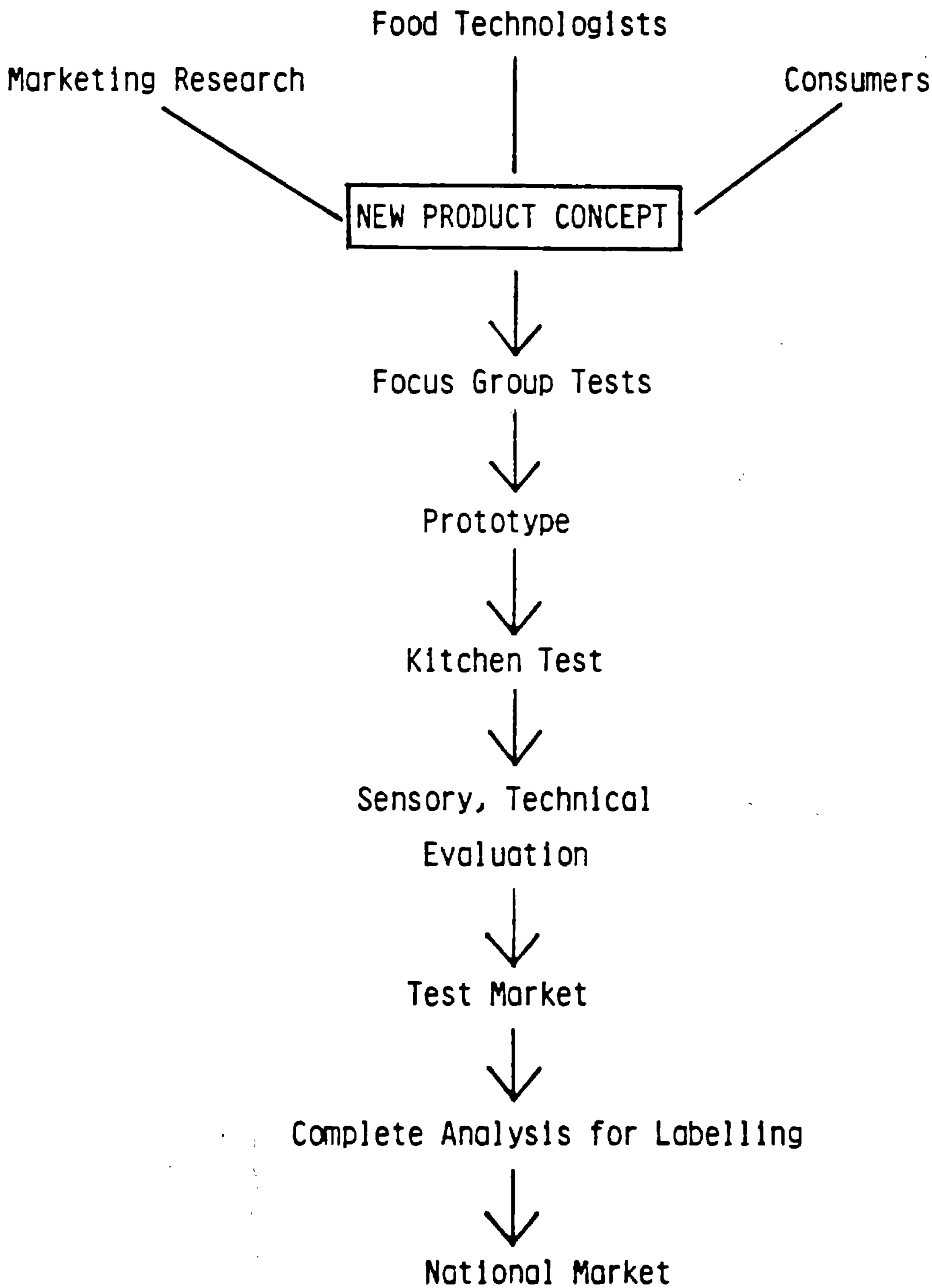


FIGURE 5.

USE OF NUTRIENT DATABASE IN PRODUCT DEVELOPMENT

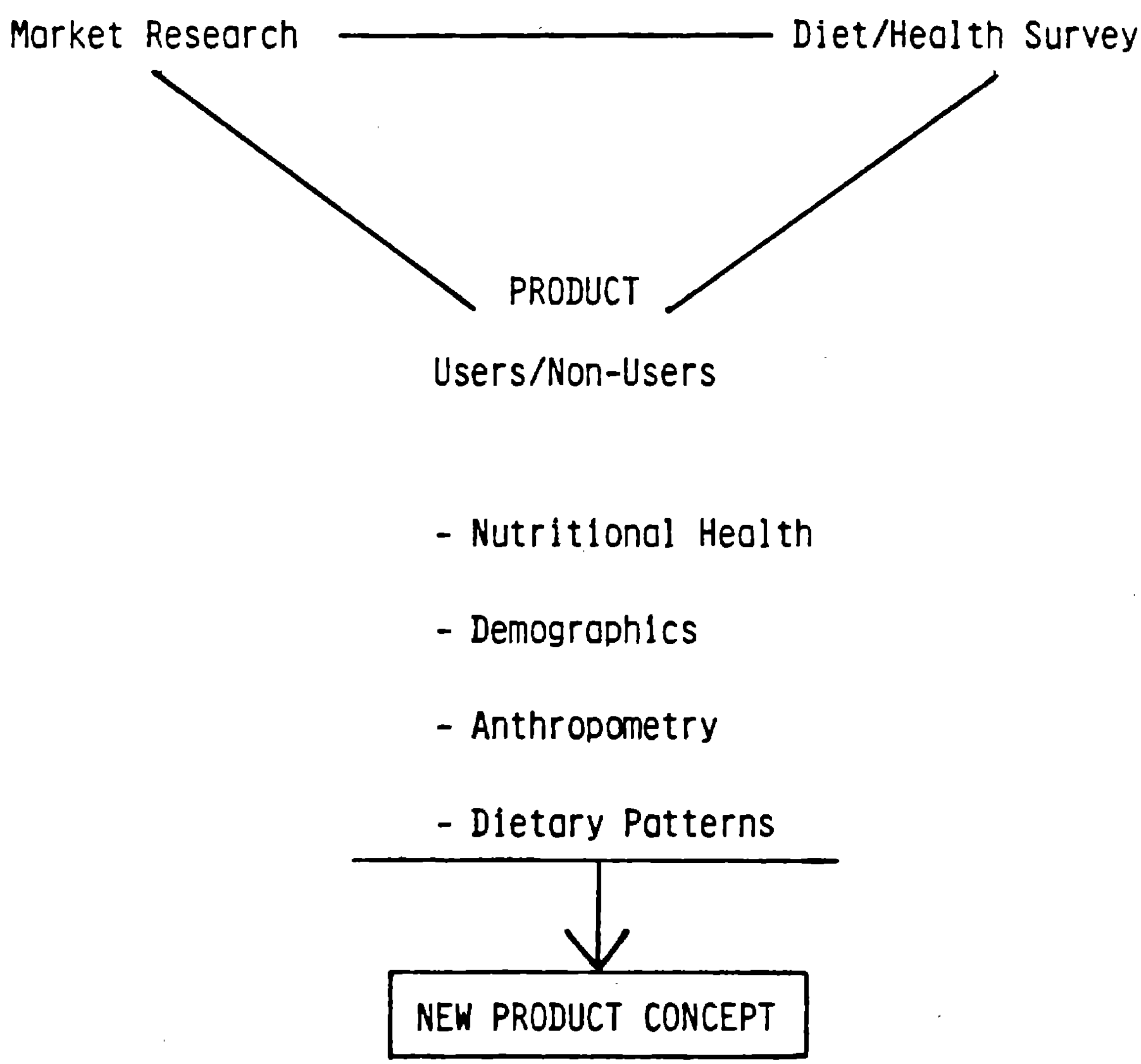


TABLE 4.

EXAMPLE

NUTRITIONAL GUIDELINES

1.	Calories	1/4 - 1/3 of the RDA (Adults) - 500 - 700 Kcal
2.	Sodium	Less than 1000 mg
3.	Nutrients	At Least 30% RDA
4.	Fat	Not More Than 30% of Calories
5.	Protein	12 - 15% of Calories
6.	Carbohydrate	50 - 55% of Calories

TABLE 5.

SAMPLE

SAMPLE	WT. GRAMS
CHICKEN, BROILER/FRYER, BREAST, MEAT ONLY	94.0
SOUP, DRIED, CHICKEN BROTH, CUBED,	1.8
LEMON JUICE, FRESH	5.0
PINEAPPLE JUICE	31.0
PINEAPPLE CUBED	65.0
GREEN BEANS	56.8
MARGARINE, LOW SODIUM	4.9
BROWN RICE CKD	14.2
FORTUNE COOKIES	0.5
SUGAR, BROWN	0.6
VINEGAR, CIDER	10.0
ALMONDS, CHOPPED	1.8

Figure 6.

USE OF NUTRIENT DATABASE IN PRODUCT DEVELOPMENT

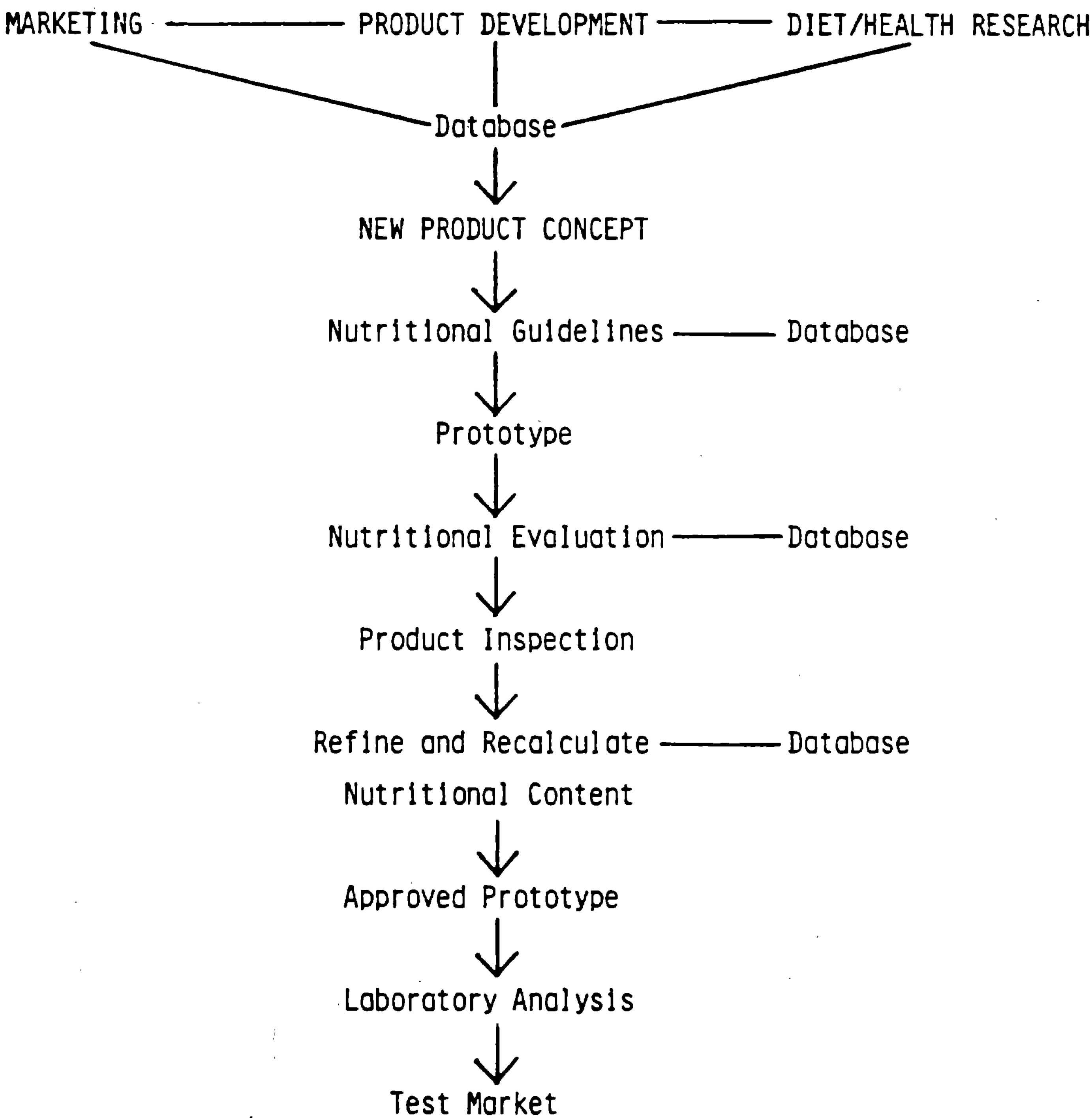
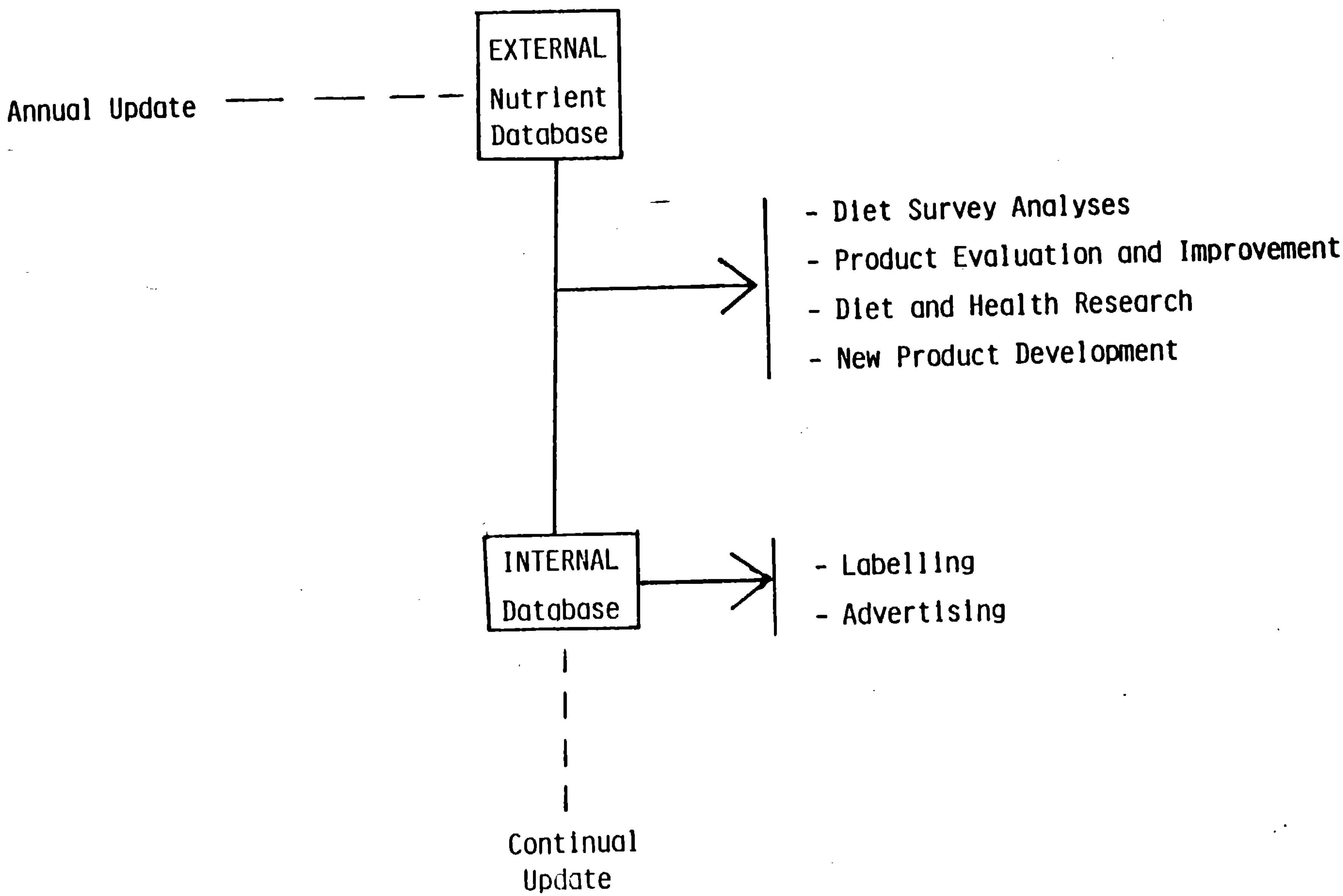


FIGURE 7.


Annual Update
EXTERNAL
Nutrient
Database
- Diet Survey Analyses
- Product Evaluation and Improvement
- Diet and Health Research
- New Product Development
INTERNAL
Database
- Labelling
- Advertising
Continual
Update