IV. PROPOSED DEFINITION OF DIETARY FIBER

The Panel on the Definition of Dietary Fiber proposes two definitions to encompass current and future nondigestible carbohydrates in the food supply that are considered to be meaningful subdivisions of the potential substances that could be included:

1. *Dietary Fiber* consists of nondigestible carbohydrates and lignin that are intrinsic and intact in plants.
2. *Added Fiber* consists of isolated, nondigestible carbohydrates that have beneficial physiological effects in humans.

Total Fiber is the sum of *Dietary Fiber* and *Added Fiber.*

This two-prong approach to define edible, nondigestible carbohydrates recognizes the diversity of carbohydrates in the human food supply that are not digested: plant cell wall and storage carbohydrates that predominate in foods, carbohydrates contributed by animal foods, and isolated and low molecular weight carbohydrates that occur naturally or have been synthesized or otherwise manufactured. These definitions recognize a continuum of carbohydrates and allow for flexibility to incorporate new fiber sources developed in the future following demonstration of beneficial physiological effects in humans.

Distinguishing Features

Dietary Fiber consists of nondigestible food plant carbohydrates and lignin in which the plant matrix is largely intact. Nondigestible means that the material is not digested and absorbed in the human small intestine. Nondigestible plant carbohydrates in foods are usually a mixture of polysaccharides that are integral components of the plant cell wall or intercellular structure (see Table 3). This definition recognizes that the three-dimensional plant matrix is responsible for some of the physicochemical properties attributed to *Dietary Fiber*. Fractions of plant foods are considered *Dietary Fiber* if the plant cells and their three-dimensional interrelationships remain largely intact. Thus, mechanical treatment would still result in intact fiber. Another distinguishing feature of *Dietary Fiber* sources is that they contain other macronutrients (e.g., digestible carbohydrate and protein) normally found in foods. For example, cereal brans, which are obtained by grinding, are anatomical layers of the grain consisting of intact cells and substantial amounts of starch and protein; they would be categorized as *Dietary Fiber* sources. Resistant starch that is naturally occurring and inherent in a food or created during normal processing of a food, as is the case for flaked corn cereal, would be categorized as *Dietary Fiber*. Examples of oligosaccharides that fall under the category of *Dietary Fiber* are those that are normally constituents of a *Dietary Fiber* source, such as raffinose, stachyose, and verba-

cose in legumes, and the low molecular weight fructans in foods, such as Jerusalem artichoke and onions.

Added Fiber consists of isolated or extracted nondigestible carbohydrates that have beneficial physiological effects in humans. *Added Fibers* may be isolated or extracted using chemical, enzymatic, or aqueous steps. Synthetically manufactured or naturally occurring isolated oligosaccharides and manufactured resistant starch are included in this definition. Also included are those naturally occurring polysaccharides or oligosaccharides usually extracted from their plant source that have been modified, for example to a shorter polymer length or to a different molecular arrangement. Although it has been inadequately studied, animal-derived carbohydrates such as connective tissue are generally regarded as nondigestible. The fact that animal-derived carbohydrates are not of plant origin forms the basis for including animal-derived, nondigestible carbohydrates in the *Added Fiber* category. Isolated, manufactured, or synthetic oligosaccharides of three or more degrees of polymerization are considered to be *Added Fiber*. Nondigestible monosaccharides, disaccharides, and sugar alcohols are not considered to be *Added Fiber* because they fall under "carbohydrates" on the food label.

Rationale for Definitions

Nondigestible carbohydrates are frequently isolated to concentrate a desirable attribute of the mixture from which it was extracted. Distinguishing a category of *Added Fiber* allows for the desirable characteristics of such components to be highlighted. In the relatively near future, plant and animal synthetic enzymes may be produced as recombinant proteins, which in turn may be used in the manufacture of fiber-like materials. The definition will allow for the inclusion of these materials and will provide a viable avenue to synthesize specific oligosaccharides and polysaccharides that are part of plant and animal tissues.

Three established physiological effects of *Added Fibers* are recognized at this time as beneficial to human health. These are attenuation of postprandial blood glucose concentrations, attenuation of blood cholesterol concentrations, and improved laxation. Rapidly changing lumenal fluid balance resulting from large amounts of nondigestible mono- and disaccharides or low molecular weight oligosaccharides, such as what occurs when sugar alcohols are consumed, is not considered a mechanism of laxation for *Added Fibers*.

Nondigestible carbohydrates may influence specific aspects of immune function, particularly since the small intestine embodies quantitatively the largest proportion of immune tissue in mammals (Kelly and Coutts, 2000; McKay and Perdue, 1993). Furthermore, nearly all fibers are fermented to some extent, producing short-chain fatty acids for which a variety of physiologic roles are being identified (Bugaut and Bentejac, 1993; Fleming and Yeo, 1990; Mortensen and Clausen, 1996). However, insufficient data and a lack of consistency in available experimental results limit recognition of some beneficial physiological effects

related to immune function at this time. The two-pronged approach to defining fiber, however, allows for future addition of these and other beneficial physiological effects as they are identified and characterized with some certainty.

In summary, one definition has been proposed for *Dietary Fiber* because many other substances in high fiber foods, including a variety of vitamins and minerals, often have made it difficult to demonstrate a significant health benefit specifically attributable to the fiber in foods. Thus, it is difficult to separate out the effect of fiber per se from the high fiber food. Attempts have been made to do this, particularly in epidemiological studies, by controlling for other substances in those foods, but these attempts were not always successful. The advantage, then, of adding isolated nondigestible carbohydrates as a fiber source to a food is that one may be able to draw conclusions about *Added Fiber* itself with regard to its physiological role rather than the vehicle in which it is found. The proposed definitions do not preclude research directed towards the health benefits of *Dietary Fiber* in foods, but it is not necessary to demonstrate a physiological effect in order for a food fiber to be listed as *Dietary Fiber*.

Two important aspects of the recommended definitions are that some fibers are *Added Fibers* and that a substance is required to demonstrate a beneficial physiological effect to be classified as *Added Fiber*. Research has shown that extraction or isolation of a polysaccharide, usually through chemical, enzymatic, or aqueous means, can either enhance its health benefit (usually because it is a more concentrated source) or diminish the beneficial effect. These recommendations should be helpful in evaluating diet and disease relationship studies as one will be able to classify fiber-like components as *Added Fibers* due to their documented health benefits. Although databases are not currently constructed to delineate potential beneficial effects of specific fibers, there is no reason that this could not be accomplished in the future.

Inclusion of Lignin as Dietary Fiber

It is recognized that lignin consists of phenolic compounds and not carbohydrates. Although lignin is present in the North American food supply in only small amounts, it is included as *Dietary Fiber* for two reasons: it is covalently bound to fiber polysaccharides, and its presence alters the physiological effects of the fiber. For example, fermentability of fiber polysaccharides is reduced by lignin (Jung, 1989; Titgemeyer et al., 1991). Definitions of dietary fiber promulgated by Health and Welfare Canada, Germany, and AACC, as well as the definition proposed by ANZFA, specifically include lignin. Lignin is the only fiber-associated substance included in the definition of *Dietary Fiber* and is only included when it is part of the intact plant matrix.

Exclusion of Specific Physiological Effects

Specific physiological effects are not part of the definitions because new beneficial effects of nondigestible carbohydrates will continue to be discovered. Furthermore, the aim of this activity was to promulgate definitions that have overall long-term applicability. Thus specific physiological benefits are not included because such a definition would become quickly outdated as new health effects become established. It is anticipated that acceptable physiological benefits will be identified during implementation of the proposed definitions.

Phasing Out the Terms Soluble and Insoluble Dietary Fiber

Physiological effects of some ingested *Dietary Fibers* and some *Added Fibers* include attenuation of postprandial blood glucose concentration and blood cholesterol concentration and improved laxation. Available data suggest that the addition of fiber sources that are viscous are capable of altering blood glucose and cholesterol concentrations (Anderson et al., 1999; Jenkins et al., 1978, 2000). Fiber sources that are slowly, incompletely, or essentially not fermented in the large intestine provide bulk and therefore optimize laxation (Birkett et al., 1997; Cummings, 1997). These two physicochemical properties, viscosity and fermentability, are recommended as meaningful alternative characteristics for the terms soluble and insoluble fiber to distinguish *Dietary Fibers* and *Added Fibers* that modulate gastric and small bowel function from those that provide substantial stool bulk. It is recommended that the terms soluble and insoluble fiber be phased out and replaced with the appropriate physicochemical property as the characterization of the properties of various fibers becomes standardized.