Evaluation Summary of Carob Bean for Use as a Cigarette Ingredient

Carob bean is Generally Recognized As Safe (GRAS) by U.S. Food and Drug Administration (FDA) for direct food additive in accordance with 21 CFR 184.1343.[1] The Joint WHO/FAO Expert Committee of Food Additives (JECFA) determined that the carob bean gum is safe at historical levels of use in food.[2] Furthermore, carob bean is approved for use by the Council of Europe (CoE No. 120).[3]

Carob bean (sometimes refered to as the powder or flour) is a product derived from milled roasted fruit pod of *Ceratonia siliqua Leguminosae*, a large evergreen tree native to the Middle East region and to the southern part of the Mediterranean. It is extensively cultivated for the seeds and fruit in Cyprus, Greece, Syria, Spain and Italy.[4] The carob tree (also referred to as the locust tree) can reach heights of 33 feet and is well adapted to arid farming conditions.[5] Carob bean (powder or flour) is produced by a continuous process of drying, grinding, and roasting of the pods. The resultant flour has a versatile array of uses in cooking, as well as, nutritional and medicinal values. Carob bean powder is almost 50% natural sugar and can be used instead of sugar in most bread and pastry products.[6]

A thorough search of the literature on carob bean failed to reveal significant information regarding the potential toxicity of carob bean. Since carob bean gum is used extensively in food manufacturing, most of the relevant published literature data involved studies conducted with carob bean gum. This summary therefore includes data derived from studies with carob bean gum. The relevance of the results of testing with carob bean gum to those that might be produced by carob bean is unknown.[6]

Carob bean gum is chemically defined as a 1,4-galactomannan polymer and biologically characterized as an indigestible polysaccharide hydrocolloid.[7] Carob bean gum moves through the small intestine and arrives in the lower bowel largely undigested.[8-10] Although decreases in serum glucose and cholesterol have been associated with ingestion of large amounts of carob bean gum by experimental animals,[11-14] the research information speaks to a secondary mechanism on these findings – through a reduction in gastric emptying and perhaps peristalsis, thereby delaying or retarding their absorption.[13]

The toxicology studies with carob bean gum further support the inert nature of this molecule. Acute toxicity studies in several species did not show any evidence of oral toxicity at doses up to 10 g/kg.[2,15,16] Subchronic toxicity studies of dose level in rodents up to 10% were unremarkable.[15-17] Similarly, dogs receiving up to 10% (7,500 mg/kg/day) of carob bean gum admixed in the diet for 30 weeks showed no evidence of a compound-related toxicity.[18] Lifetime bioassay studies in rats and mice with up to 5% (2,500 mg/kg/day for rats and 7,500 mg/kg/day for mice) dietary exposure to carob bean gum did not evoke any meaningful evidence that galactomannan possessed a carcinogenic (or a long-term toxicological) potential.[15,19] Mutagenicity studies were negative[16,20-22] and no chromosomal damage has been demonstrated.[16,22] Teratology studies were performed in four species (rats,[23] mice,[23] hamsters[24] and rabbits[24]) gave no suggestion of a teratogenic effect at levels of 910–1,300 mg/kg, although maternal toxicity was evident in rabbits and mice at the highest doses.[23,24]

Carob bean gum has similarly low toxicity in humans. Several clinical studies have failed to show that oral ingestion of carob bean gum has any adverse sequelae.[12,25,26] There is clinical data to support claims of a decrease in serum cholesterol and a blunting of the glucose-tolerance test following oral ingestion of carob bean gum, but whether this is directly related to a carob bean gum effect on gastrointestinal peristalsis or a consequence of the physical nature of the hydrocolloid structure is not known.[12,27-30] The impact of these serum biochemical findings has not been readily embraced by the medical community because carob bean gum is not normally a recommended dietary approach to correcting even marginal increases in plasma cholesterol levels or fasting glucose swings.[6]

The only finding of consequence occurred with carob bean flour, a material derived from the unrefined whole ground seed. There are reports of an allergic response to extensive inhalation exposure to this flour.[31-34] It is not known if this response is a rare occurrence. However, it does follow a pattern that has been noted with inhalation exposure to other proteinaceous materials, including soy protein.[6]

Carob bean is currently used worldwide at levels below 1,500 ppm in selected cigarette brands manufactured and/or distributed by Philip Morris USA Inc. (PM USA) and/or Philip Morris Products SA (PMP SA). Carob bean may be applied directly to the tobacco during cigarette manufacturing as a tobacco flavoring material, and as such, may be subject to pyrolysis-type reactions. Carob bean may also be applied to the filter as a flavoring material where it would not be subjected to pyrolysis temperatures.

As suggested by the purge and trap studies conducted by PM USA,[35] carob bean applied to tobacco would not be expected to extensively distill at 100°C. At the higher temperatures used in the pyrolysis studies conducted by PM USA, the identified peaks were consistent with chemicals expected from the pyrolytic decomposition of polysaccarides, and suggest that carob bean would be pyrolyzed extensively.[36]

Carob bean was part of a PM USA testing program that was designed to evaluate the potential effects of 333 ingredients added to typical commercial blended test cigarettes on selected biological and chemical endpoints.[37-40] Three pairs of test cigarettes were produced, each containing different groups of ingredients. Carob bean was added to one pair at target levels of 1,165 and 1,748 ppm. No significant effects were noted in cytotoxicity, mutagenic studies or in respiratory tract endpoints in 90-day rat inhalation studies. In addition, smoke chemistry studies from cigarettes containing a mixture of flavors including carob bean did not significantly alter the smoke chemistry profile compared to control cigarettes. Based on the results of these studies, the authors concluded that these ingredients (including carob bean) added to tobacco do not add significantly to the overall toxicity of cigarettes.

Currently, information is only available for tests utilizing carob bean at levels below the current use level. Studies are ongoing to address the use of carob bean at higher tobacco application levels. While the current use level exceeds the levels that have been tested, published studies show there is no meaningful difference in the composition or toxicity of smoke from cigarettes with added ingredients (including carob bean) compared to the smoke from cigarettes without

added ingredients.[37-44] Based on the best available data, the ingredients used in PM USA and/or PMP SA cigarettes do not increase the overall toxicity of cigarette smoke.

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