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In order to illustrate the compositional effect of carbohydrate additives on tobacco smoke, the data of Gager (12) and Gager (13) have been recalculated, using the assumption that 210 ml of smoke was generated per cigarette in these reports. Using the radioactive conversions reported, the data may be expressed as the equivalent weight or volume of each reported component per liter of smoke. The data were then scaled to 100% by weight, using the figures reported on the cigarette weight and added carbohydrates. Thus, tobacco smoke composition can be compared to «glucose or sucrose smoke» composition. Table 1 shows the data in comparison to the smoke of the University of Kentucky reference cigarette, 1R1. With the assumptions made in these calculations, differences of less than a factor of two are not considered significant. It is concluded that the addition of the simple carbohydrates could influence the smoke composition with respect to furan, propionaldehyde, acetone, 2-methyl furan, dimethylfuran, acetonitrile, crotonaldehyde, phenols and the respective carbohydrates. However, when one considers a carbohydrate addition of 5%, the effect is insignificant on the composition of smoke with respect to the listed compounds. Although not described in the C^{14} distribution studies, it may be reasonably concluded that part of the activity found in the gross particulate fractions was due to formation of pyrazines. The conversion of sugar-amino acid combinations to pyrazines has been studied, Koehler et al (23, 24), in a model system at relatively low temperatures. The addition of sugars to tobacco relatively high in amino acids undoubtedly influences the smoke composition with respect to pyrazines.

In the instance of major carbohydrate additions, such as the use of cellulose derivatives as bonding agents in some of the reported tobacco sheet-making processes or as base materials in some of the recently publicized synthetic smoking materials, the effect on gross smoke composition is more pronounced. In addition to an increase in some of the volatile aldehydes, a decrease in the tobacco specific components such as nicotine and isoprene occurs (4).

Humectants represent another class of additive, typified by glycerine and propylene glycol. Laurene et al (26) have studied the transfer of both of these glycols to mainstream smoke. For a 70 mm nonfilter cigarette, the amount of propylene glycol transferred is 19.2%, and glycerine 8.9%. Although I am unaware of extensive decomposition studies on these compounds, it may be reasonably inferred that some decomposition occurs since the transfer rates are low when compared to menthol or dotriacontane (19), which contribute minor concentrations of decomposition products to mainstream smoke. It would generally be expected that decomposition of the glycols would be similar to some of the simple carbohydrate decomposition products, contributing little, if any, detectable gross alteration in smoke composition. Using a 1% addition of propylene glycol and 2% of glycerine, smoke volumes for 70mm cigarettes as previously estimated and the above transfer rates, smoke would contain approximately 9 mg/l of propylene glycol and 8.6 mg/l of glycerine.

Another additive which may have some use on tobacco is that of the inorganic type. For this presentation, I will confine this to two materials: nitrate, and phosphate. Both of the materials may be considered as natural leaf components, but from a review of the literature have received attention as additives.

Nitrates have been the subject of considerable experimental research (50), and one of the major effects on smoke composition is through the production of nitrogen oxides. Neurath and Ehmke (34) and Broaddus et al (6) reported the relation between oxides of nitrogen and nitrate of tobacco. Most recently, Sloan and Kiefer (40) have confirmed such a relationship. From these publications, one would estimate that an 85 mm nonfilter cigarette containing about 1% nitrate would yield 1.25 mg/l of NO and 40 µg/l of NO_2 in the mainstream smoke. In addition to the direct contribution of nitrate to oxides of nitrogen, various authors have reported effects on smoke constituents. Kallianos et al (22) have reported an inverse relationship between the yield of mainstream catachol and the percent nitrate on tobacco. Hoffmann and Wynder (17) have reported reductions in tar, nicotine, phenol and benz (a) pyrene when comparing a normal tobacco to one containing 8.3% sodium nitrate. Similar reductions are reported by Burdick et al (7). Sloan and Sublett have also suggested that methylnitrite is formed from the reaction between methanol and nitrogen oxides in the mainstream smoke. Similarly, aldehydes, isoprene and hydrogen sulfide have been reported to react with oxides of nitrogen in mainstream smoke (35), as well as methyl mercaptan (40).

Terrell and Schmeltz (42), Bell (3) and Hoffmann (17) have compiled data comparing the smoke composition of control cigarettes to those with 8.3% added sodium nitrate (Table 2). For the highly

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