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NICOTINIC ACID

UTILISATION OF TOBACCO WASTE

CONCLUSIONS:

(1) The manufacture of nicotinic acid from quinoline and β-picoline is well established; it is competitive and the product is used in comparatively small quantities so that transport charges are negligible. Under ordinary conditions the cost of nicotinic acid made from nicotine would be several times that made from quinoline.

(2) Nicotinic acid can be made from tobacco waste in a number of ways. It is possible that the direct oxidation (without isolation of nicotine) could be developed satisfactorily to produce an animal food and nicotinic acid or nicotinic acid alone and that this might be more attractive than first isolating nicotine.

(3) If in the future nicotine and tar extracts were produced as waste products from the solvent extraction of tobacco, then the profitability of manufacturing nicotine, nicotinic acid and other compounds should be examined.

(4) The medical and biological literature should be continuously watched for indications of materials which could be made from tobacco. In this connection, the future development of ubiquinones is of interest to tobacco manufacturers.

INTRODUCTION

The object of this note is to give some preliminary consideration to the possibility of producing nicotinic acid from tobacco waste. This possibility probably assumes some importance in countries with low standards of nutrition where nicotinic acid is imported in insufficient quantities and yet where an apparent raw material for the vitamin is not used.

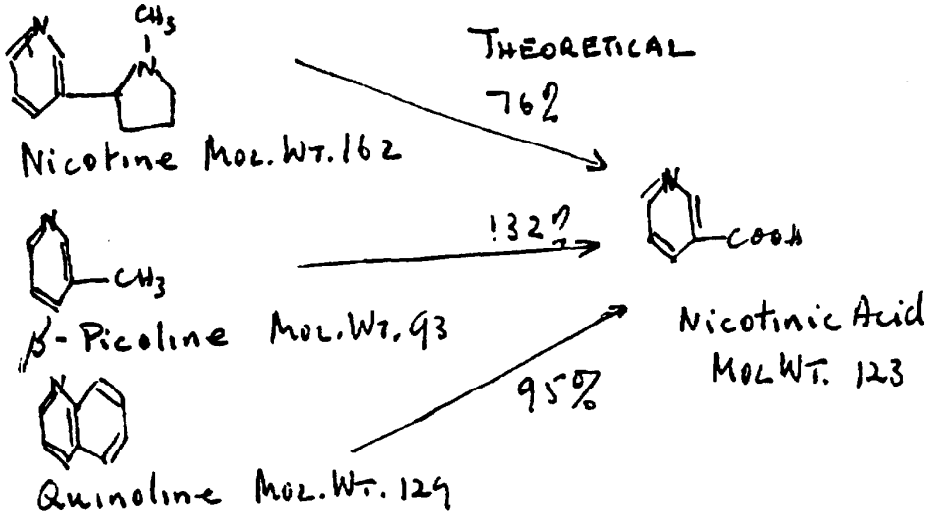
Nicotinic acid (Niacin, Niconacid, Nicyl, Akotin) is the anti-pellagra vitamin pyridine-β-carboxylic acid. It is now widely used as a food supplement and in the United Kingdom, for example, it is a Statutory requirement (Flour Order 1953) that it shall be present to the extent of 1.600 mgm. per 100 gm. flour. It is also added rather indiscriminately as an extra claim to many proprietary breakfast foods, tonics, etc. The U.K. consumption is guessed at 200,000 lbs. p.a. and the American at something over 600,000 lbs. p.a. On the other hand the consumption of manufactured nicotinic acid in India in 1952 was less than 10,000 lbs. Nicotinic acid is present in a wide variety of foods and the normal requirement is about 10 mgm. per man per day. This requirement is easily covered in a normal western diet containing, for example, meat (10 mgm. nicotinic acid per 100 gms.) and potatoes (1 mgm. nicotinic acid per 100 gms.) but may not be met in some diets, for example, based on milled rice (2 mgm. nicotinic acid per 100 gms.). It is likely that the world demand for manufactured nicotinic acid will continue to expand over the next decade. The expansion over the last 20 years led to much consideration of processes by the chemical industry and it is likely that further consideration is justified now with a view to the expansion in demand expected in Asia and South America.

MANUFACTURE OF NICOTINIC ACID : Present

Nicotinic acid was first made by the oxidation of nicotine and Whiffens operated a commercial process in this country starting with tobacco. Later they were supplied with nicotine by the British Nicotine Company and continued the oxidation. Finally - before the Second World War - they found they were unable to compete with manufacturers starting from quinoline and the nicotine process ceased. Nicotinic acid is now made almost entirely from quinoline and β-picoline, although it could be made directly from tobacco waste [2], from pyridine, some

other coal tar bases, nicotine, anabasine, nor-nicotine or mixed tobacco alkaloids. The U.S. Dept. of Agriculture sponsored work aimed to make nicotine compete, as early as 1942, but although a new catalytic oxidation process was developed quinoline was still the cheapest source of nicotinic acid [3]. Comparative costs were published in 1951 by Coal Tar Products of Philadelphia and with nicotine at $ 2.5/lb. β-picolin at $ 0.95 and quinoline at $ 0.5, nicotine was shown again to be a non-starter.

That this position remains is readily shown. Considering the theoretical yields as follows:



56% of the weight of nicotine is the maximum possible which can be used in the nicotinic acid molecule compared with 62% for quinoline and 79% for β-picoline.

Thus, even if reaction costs were the same in each case, the price of nicotine, in order to compete with the others, must be considerably lower. Actually, in practice the yield from quinoline is about 95% theory and that from nicotine about 75% theory, and also more oxidising reagent must be used in the case of nicotine.

But ignoring those practical disadvantages and assuming the nicotine process could be developed to be as good as the quinoline process,in efficiency and operating cost, then nicotine would have to enter the process at 2/1d./1b. to compete with quinoline at 2/6 per 1b. (92%) the present U.K. price. (The present pricefor 96% β-picoline is 7/6 per 1b. but it is difficult to obtain). The present price for nicotine on the same basis as quinoline (U.K. 1 ton lots) is 9/6 to 12/6 1b. There is no danger of a shortage of quinoline since in addition to its presence in coal tar it can be made from simple materials quite readily. It can be concluded - since British nicotine is exported quite competitively - that at present, using established nicotine extraction processes, no case can be made on economic grounds for considering making nicotinic acid from nicotine.

NICOTINIC ACID FUTURE POSSIBILITIES

(1) In spite of the present indications above it is still possible that conditions could be changed to put tobacco or nicotine into a more competitive role. The nicotine extraction process appears surprisingly expensive. However, in terms of tobacco waste the cost is of the order of 1d./1b. treated and this compares quite well with tobacco processing and not too badly with comparable chemical processing. It is difficult to generalise from a brief examination of a single plant (B.N.Co. Liverpool) but since this plant is competitive in world markets, it is perhaps permissible. It is likely that nicotine extraction is rather expensive because the plants are relatively small scale, the processes are essentially one-product, and there is a residue disposal cost. In addition, the extraction cost is almost directly related to the nicotine content of the waste and this is low (about 1.5%). The extraction of nicotine could become much cheaper if it were part of normal tobacco processing, or if a suitable credit were obtained for the extracted waste residue or if other more expensive materials

could be separated and successfully marketed.

(2) Solvent Extraction of Tobacco

Some consideration is being given to the solvent extraction of tobacco blends aimed to reduce tar and nicotine[8]. If this were adopted as part of general tobacco processing on a reasonable scale then much more nicotine would become available than before. Instead of having the tobacco waste only, all the tobacco processed would be available for the removal of, say, 1% nicotine. The by-product from a solvent extract process would be a tar rich in nicotine so that the extraction cost for nicotine might well be below 6d/lb. Certainly the chances of nicotine competing with quinoline would become very bright. If solvent extraction of tobacco is contemplated on a commercial scale it is strongly recommended that this aspect be considered - particularly the manufacture of nicotinic acid itself. In this event further possibilities from cheap nicotine may be developed and in particular the conversion of nicotine to iso-nicotinic acid hydrazide would form an attractive speculative research project. At present iso-nicotinic acid hydrazide (Isoniazid), the anti T.B. drug, is made from γ-picoline which is expensive; it may be that a solvent extract of tobacco would contain a sufficient concentration of some γ-substituted pyridine compound to compete with γ-picoline or, alternatively, that with very cheap nicotine a low yield conversion process could become acceptable.

(3) Extracted Tobacco Waste

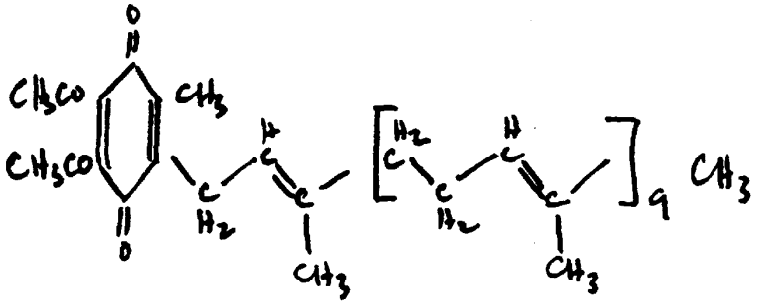
The residue from the normal nicotine extraction of waste tobacco has some value as a fertiliser and composts well but slowly. However, it usually contains at least 70% of water and its value for composting, etc., is unlikely to equal the cost of drying or transport of water. At present it must be assumed that a waste disposal cost (probably lowest if the waste were burned) is associated with conventional nicotine extraction.

(4) Direct Tobacco Route to Nicotinic Acid

A General Cigar Patent [2] claims that nicotine in tobacco waste can be oxidised with air directly to nicotinic acid, i.e. under conditions where nicotine itself could not be so oxidised. In the patent, however, the nicotinic acid must then be extracted from the tobacco with water or some solvent so that again a wet residue is involved. It is possible that a process could be developed where the nicotinic acid is sublimed from the tobacco waste and that this might be more attractive. To establish this would, of course, require experimental work related to a specific end use for the tobacco residue or to using the residue as the source of energy for sublimation.

OTHER MATERIALS FROM TOBACCO WASTE

If other products of high value could be extracted along with nicotine, the extraction of the latter from tobacco waste might become more profitable or the cost of nicotine could fall. Such a material would have to be in the high price range associated with drugs. At present there is no such material on the horizon, although it is just possible that ubiquinone [7] (Co-enzyme Q) or some related compound may become important in medicine. Ubiquinone has been found in tobacco as also has solanesol, a long chain alcohol which could provide part of the ubiquinone molecule. [4, 5, 6]



Ubiquinone or Coenzyme Q_{10}

Ubiquinone is known to be a normal constituent of many animal tissues and in some senses is a vitamin since the benzene ring is not known to be synthesised in man. It is known that Hofmann - La Roche are carrying out extensive work on this in Switzerland, and it would be interesting to know if they have considered tobacco as a raw material.

In addition, the isolation of α-tocopherol and solanachromene from flue cured tobacco suggests that the tobacco plant may contain a range of biologically imp rtant compounds such as Vitamin E and Vitamin K as well as compounds related from solanesol (6).

However, none of this is very exciting, first because Reynolds have published fairly widely in this field and must be assumed to be well aware of the possibilities, and second because the type of compound considered does not have a molecule intrinsically very difficult to synthesise from cheap materials. As a guess for example, if ubi-quinone became important, the market price would quickly drop to a few shillings per gram. Nevertheless, this aspect is worth watching and the political impact of the tobacco industry making a contribution to medicine might be considered important.

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