

flooding and flushing, which is worthy of being studied and followed in present times.

(2) A change of policy on the part of the zemindars, big landowners, and rich men with vested interests is necessary for the improvement of sanitation in this Province.

(3) The common people should be led to take the initiative in sanitary measures by propaganda work.

(4) The experiences at Lohagora bundh-area prove definitely the good effects of flooding and flushing in checking epidemic malaria.

THE DELETERIOUSNESS OF POTABLE SPIRITS ON THE INDIAN MARKET.

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THE potable spirits offered for sale to the public in India fall under three main categories:—

(1) *Genuine and fully matured spirits.*—Genuine spirits consist of a solution of ethyl alcohol in water, together with sufficient quantities of the by-products of fermentation to confer a characteristic odour and flavour to it. Any one with sufficient experience can distinguish between the three fermentation bases used, namely, cereal grain for whisky, grape juice for brandy, and products of sugar-cane for rum. In old days pot-stills were exclusively used for the distillation of spirits and larger quantities of esters, higher alcohols, etc., were left which were responsible for the characteristic flavour and taste. By storage in wooden casks changes are brought about in the character and amount of these secondary constituents with the result that the flavour is improved. All the matured spirits including whiskies, brandies, etc., are covered by a certificate of age to the effect that they are over three years old. Proof of maturation is by official certificates from the Government of the country exporting, stating the number of years the spirit covered by the certificate has matured in the wood. In Australia all spirits must be stored for two years in bond. In the Union of South Africa three years' bonding is specified for spirits other than gin and liquors. *The Immatured Spirits (Restriction) Act, U. K., 1915*, laid down that all plain spirits intended for human consumption should be kept in bond for a period of three years before issue. It has not been specified whether the storage should be in wooden casks or not. This act, however, was not passed for hygienic reasons, but was primarily intended as a war measure to restrict the consumption of spirit in the national interest. It does not prevent the use of new spirits in the preparation of compound spirits such as gin, British brandy, etc., provided certain duties are paid. The retail price

at which these spirits are sold is over Rs. 84 per dozen bottles, as the storing of spirits for long periods naturally increases the price. In practice most of the good brands of spirits are stored for considerably longer periods than the three years specified by the British and French excise regulations.

(2) *Genuine but immature spirits.*—These spirits are genuine in so far as they are made from the same fermentation bases as class (1). They are generally distilled by means of "patent stills," which are so arranged that an appreciable quantity of the secondary products, but much less than in case of the pot-still, is left behind. Long maturation is therefore not necessary for these spirits. There are quite a large number of such spirits on the market. The whiskies are the produce of Scotland and the brandy that of France, but they are said to be very immature spirits as they could not have been stored for long enough periods to mature owing to their very low price. The selling price of most of these brands is between Rs. 40 to Rs. 55 per dozen bottles.

(3) *Imitation or factitious spirits.*—A very large number of such spirits are now offered for sale. These imitation spirits consist of diluted alcohol which has been so far stripped of the by-products by means of effective "patent stills" that the fermentation base is no longer discernible, and certain odourous and flavouring substances giving the flavour and odour of the genuine spirits are added to it in minute quantities. Two things are required for making imitation spirits; firstly, ethyl alcohol, rectified spirit being generally used, and secondly, flavouring agents, usually added in form of essences. The composition of these essences varies according to the particular spirit that is to be made, and various firms have elaborated their own formulæ. The basic substances in all the essences are esters, peculiar to each spirit, e.g., ethyl butyrate, ethyl acetate and ethyl formate occur in rum; ethyl acetate and ethyl nitrite in whisky; and spirits of nitrous ether and amyl capionate in brandy and cognac. These imitation spirits by analysis contain much smaller quantities of the by-products than a genuine spirit and therefore have a comparatively mild taste.

Of late years the Indian market has been flooded with many different brands of these imitation spirits—whisky, brandy, rum, etc., imported from Germany and other countries. These spirits are put into very attractive looking bottles with beautiful labels and are considerably cheaper than the "genuine spirits," the sale price being Rs. 20 to Rs. 40 per dozen bottles. They can be sold cheaply because inexpensive fermentation bases such as potatoes, rice, etc., are used in their preparation. On account of their low cost and milder taste the public prefer them and the demand for them appears to be rapidly increasing. The

question has therefore arisen as to whether these imitation spirits, on account of the cheap cost of their production owing to cheaper raw materials which are used in their manufacture, contain products which are more harmful than those contained in the genuine spirits.

DELETERIOUSNESS OF GENUINE MATURE AND IMMATURE SPIRITS AND IMITATION SPIRITS.

The harmful and toxic effects of spirits were in the past attributed to the by-products. The foundation of this belief rested on the fact that the first distillate from a mash in the case of pot-still liquors was very unpleasant and undrinkable. No one had paid any attention to the large quantities of ethyl alcohol which were present. The question was thoroughly gone into by the Playfair Committee in 1891, who came to the conclusion that immature spirits were not deleterious, but unpalatable. As regards the imitation spirits the same committee concluded that these spirits were no more harmful than genuine spirits. In those days very few of the imitation spirits were in use and only a limited number of flavouring essences were employed. In India the question was examined thoroughly by Sir C. H. Bedford in 1906 with special reference to alcoholic liquors produced in this country as well as of the liquors which were imported. A large amount of experimental work was done and the conclusions drawn were (a) that alcohol alone was at least as deleterious as alcohol plus by-products; (b) that the by-products, though undoubtedly noxious, in the relatively small quantities in which they are found in even the worst samples of potable liquors have negligible effects; (c) that spirit drinking was noxious because of the toxicity of ethyl alcohol; (d) that on hygienic grounds there was no reason to discriminate between most of the good quality of imported spirits, the cheap imported spirits, and the factitious Indo-European spirits. Cheaper spirits distilled from the cheap fermentation bases were not more deleterious than the better class spirits. The Royal Commission on potable spirits in 1909 confirmed in the main all the findings of the Playfair Committee and the Bedford report. Alcohol and not the by-products was chiefly responsible for all the toxic effects produced by potable spirits. Cheaper spirits distilled from cheap fermentation bases were not deleterious because of the by-products they contained, but because excessive quantities of alcohol were consumed which produced harmful effects.

It is obvious from this that while the toxicity of ethyl alcohol and the by-products produced during the course of distillation of potable liquors, which are responsible for the taste of the liquor, has been fully investigated, the toxicity of the essences used for purposes of flavouring the imitation spirits and the toxicity of the imitation spirits now largely

consumed in this country has not been thoroughly investigated. Further, I am unable to find any experimental data to show whether the immature genuine spirits were any more toxic than the mature genuine spirits. As this matter is of great importance from the point of the health of the public, a large series of experiments were conducted at the instance of the Government of India to settle these points.

EXPERIMENTAL EVIDENCE.

A large number of animals, mostly cats, were used for this investigation. Batches of animals were kept in large cages in which they could move about freely and were given a routine diet consisting of boiled meat, fish and rice. They were carefully weighed before and after the experiments and watched for the appearance of any untoward symptoms. At the completion of the experiment the animals were killed and a careful post-mortem examination was made and any changes produced were recorded. Parts of all the important organs such as the liver, kidney, suprarenals, stomach, intestine, pancreas, lungs, etc., were removed for microscopical examination. This involved a very large amount of work and I am very grateful to my colleague Lieut.-Col. H. W. Acton, I.M.S., Professor of Pathology, Calcutta School of Tropical Medicine, for giving his expert opinion on the pathological findings. Two separate sets of experiments were arranged.

Experiments; Group A.—The first group were carried out in order to determine the toxicity of certain essences used in the preparation of imitation spirits now on the market. These included essences for preparing imitation whisky, brandy, gin and rum, manufactured by well known British firms. I used these in all my experiments, taking them as typical examples of the essences used commercially in preparation of imitation spirits.

(1) Ten per cent. solutions of the essences dissolved in 42 per cent. of alcohol (by volume) in water were given intravenously to intact animals under experimental conditions. There was no appreciable effect on the heart, blood pressure, respiration, or other organs of these animals. The proportion of the essence of whisky in ordinary imitation whisky is 1 of the essence in 5,333, so that when such spirits are consumed and circulate in the blood in much lower concentrations the effects produced will be negligible. Perfusion of the isolated mammalian heart, which is very susceptible to toxic substances, with 1 in 2,500 to 1 in 20,000 dilutions of the essence had only a slight depressing effect. In the human body these essences would not probably circulate in stronger concentrations than 1 in 100,000 to 1 in 150,000 and the chances of any direct action on this organ are negligible.

(2) Large quantities of the essences such as 30 to 60 minims in 4 c.c. of rectified spirit (B. P.) diluted 42 per cent. by volume were given to a series of animals by the stomach tube. No toxic symptoms either immediate or remote were noticed. In the dilutions in which they exist in the potable spirits their effect on the gastro-intestinal tract would be non-existent. Subcutaneous injections of pure essences in doses of 15 to 30 minims in a solution in diluted rectified spirit produced neither any general nor local, immediate or remote, effects.

(3) The lethal dose of ethyl alcohol to cats was 7 c.c. to 9 c.c., whether the essences were added to it in 1.0 c.c. doses or not. Symptoms such as intoxication, jaundice, and general toxæmia were not greater in the case of cats which were given alcohol plus essence, than in those which were given alcohol alone.

(4) A series of cats were fed daily for a

degree of pathological changes than those which had alcohol alone.

Experiments; Group B.—Thirteen specimens of the common potable spirits, including those considered to be genuine and fully matured, genuine but immature, and imitation or factitious spirits, were bought through the courtesy of one of the firms of wine and spirit importers and my investigations were mainly confined to these samples. Before proceeding with animal experiments all these samples were chemically examined with a view to determine, firstly if any methyl alcohol was present, and secondly to find out the exact quantity of ethyl alcohol present in every specimen, so that the dosage of each brand could be calculated exactly in terms of ethyl alcohol per kilo body weight of animals. The following table gives the result of the analysis kindly carried out by Mr. Jenks, the Chemical Examiner for Customs and Excise.

TABLE I.

13 specimens of potable spirits (in bottle) offered for sale in the Indian market with original seals and capsules.

No.	Description.	Real strength, alcohol % by volume (v/v)	Denige's test for methyl alcohol.	REMARKS.
1	Scotch Whisky	43.25	Negative	Matured.
2	Ditto.	44.24	Ditto.	Ditto.
3	Ditto.	44.85	Ditto.	Ditto.
4	Ditto.	43.37	Ditto.	Considered immature.
5	Ditto.	43.37	Ditto.	Ditto.
6	Ditto.	43.14	Ditto.	Ditto.
7	German Whisky	43.70	Ditto.	Imitation spirits.
8	Ditto.	43.76	Ditto.	Ditto.
9	Brandy French No. 1	47.13	Ditto.	Considered matured.
10	Ditto. No. 2	44.39	Ditto.	Ditto.
11	Ditto. No. 1	45.93	Ditto.	Ditto.
12	German Brandy	44.10	Ditto.	Imitation spirits.
13	Java Brandy, bottled in India	43.94	Ditto.	Ditto.

N.B.—The remarks' column shows the category under which these specimens were classed by commercial experts.

period of one month (a) with 4 c.c. of alcohol largely diluted; (b) with the same amount of spirit plus essences in a concentration of 1 of essence in 250 to 500 parts of diluted alcohol. The animals of both batches were carefully watched during the experiment. They all lost weight and became thin and emaciated. At the end of this period these animals were killed and a thorough examination, both macroscopic and microscopic, was made of all the organs. Both groups showed marked gastro-intestinal catarrh and apparent changes in the abdominal organs. The histological changes, chiefly consisting of fatty infiltration, cloudy-swelling, fatty degeneration and increased formation of interstitial tissue, were confined chiefly to the liver and the kidneys. These were no more marked in those animals which were fed on rectified spirit plus essences than in those which received rectified spirit alone. As a matter of fact the animals which had the essences in addition showed a milder

The effect of the different brands was then tested on animals. The results were as follows:—

(1) Intravenous injections of these spirits in intact animals in doses ranging from 0.1 to 1.0 c.c. produced exactly the same effects on the heart, blood pressure, respiration, etc. There is no reason to suppose that their behaviour will be different when they enter the circulation through the alimentary canal and circulate in very much smaller concentrations. On the isolated mammalian heart also in dilutions of 1 in 5,000 to 1 in 20,000 the depressing effects of all the different samples were equal. Further, the effects produced did not differ materially from those given by similar concentrations of pure ethyl alcohol. The lethal doses of all brands of spirits to cats were about the same and in terms of alcohol present corresponded to those obtained in the experiments in Group A (3).

(2) A large series of animals were divided into three batches and were fed for 10 days on doses of these spirits calculated at 1 c.c. of ethyl alcohol net per kilogram body weight of the animal. One batch was put on the genuine matured spirit, another on genuine but immature spirits, and the third on imitation spirits. The dose selected was purposely small as cats are particularly susceptible to alcohol. Ten days was selected as the period during which this dosage was to be administered, as this period was found to be quite sufficient to produce changes in the animal organism without rendering the animal too weak and emaciated. All the animals lost in weight to the extent of 15 to 25 per cent. due in all probability to the general gastro-intestinal catarrh that was always set up very rapidly. After 10 days the animals were killed and all their organs were carefully examined macroscopically and microscopically. The organs chiefly affected were the gastro-intestinal tract, the liver and the kidneys; the changes were fatty infiltration, fatty degeneration, cloudy swelling, and increase of interstitial tissue. All the three groups of animals showed these changes in equal proportions.

(3) Two batches of animals were fed on large toxic doses of genuine fully matured whisky and brandy and two with imitation whisky and brandy. The doses were calculated on the basis of 4 c.c. of alcohol per kilo body weight. The average number of days of life, the loss in weight and the pathological finding, in different organs such as the kidney, liver and gastro-intestinal tract were the same.

DISCUSSION.

From the first group of experiments one is justified in concluding that the essences used for making factitious potable spirits now on the market are not toxic substances. As the imitation spirits are made from rectified spirit by adding small quantities of the essences to give the peculiar flavour of the liquor, it is reasonable to conclude that the imitation spirits are not deleterious because of the presence of these essences. The other important constituent is ethyl alcohol, which is common to both imitation and genuine spirits. From the analysis of the data obtained from the experiments in Group B one is justified in concluding that the toxic effects on animals of the three classes of spirits, i.e., genuine and mature spirits, immature genuine spirits, and imitation or factitious spirits are about equal.

Further, there is ample evidence to show that the fermentation base is not an important factor in the deleteriousness of potable spirits. Potato-spirits are not more deleterious than the sugar spirits or the grain spirits. Ninety-ninth parts of the spirits consumed in Germany is potato-spirit, in Great Britain grain spirits are

consumed, and in France and India sugar spirits are drunk. It cannot be imagined that potato-spirits are harmless to Germans but deleterious to an Englishman or an Indian, whether labelled whisky, brandy or gin: or that rectified grain spirit is harmless to all when taken as gin, but is deleterious when sold as cheap Scotch or imitation whisky. Sir Lauder Brunton, giving evidence before the Playfair Committee, suggested that the spirit distilled from rotten potatoes may contain tasteless alkaloids and other dangerous ingredients but the Royal Commission of 1909 failed to find any evidence of the presence of poisonous ingredients in such distillates. Gin containing one of these essences is largely consumed and no fault has been found with the British brandy in whose composition these essences occur. Further, the quantities of these essences in the imitation spirits is very small and no case of poisoning has been recorded from them. The higher alcohols and esters are present in minute quantities and the colouring matter is almost always the one used in genuine spirits (caramel), and also a duty approaching 1,000 per cent. of their value is staked on the quality of these articles.

From these considerations and from the data I have gathered from my experiments, I am justified in drawing the following

GENERAL CONCLUSIONS.

(a) The essences used in the preparation of imitation spirits are not deleterious to the animal organism, even when consumed in much larger quantities than those present in these spirits.

(b) Genuine and fully matured, genuine immature, and imitation or factitious spirits are equally deleterious to animals.

(c) Ethyl alcohol is mainly responsible for the deleterious effects of potable spirits; the by-products occur in such small quantities that their effect is negligible.

(d) The danger of cheap spirits (immature genuine, and imitation) lies in the fact that the consumer takes larger quantities, partly because of their low cost and partly because of their milder taste.

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