TODDY EFFLUENTS FROM DISTILLERIES

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Introduction

THE rational utilization of waste matters which are produced so frequently and abundantly in industrial operations is of more than ordinary importance.

It is common knowledge that the waste products of many manufacturing processes are thrown on one side as useless. They accumulate in large quantities if they are inorganic ; if organic, they become exposed to gradual decay and constitute a public nuisance due to river pollution, offensive smells and flies.

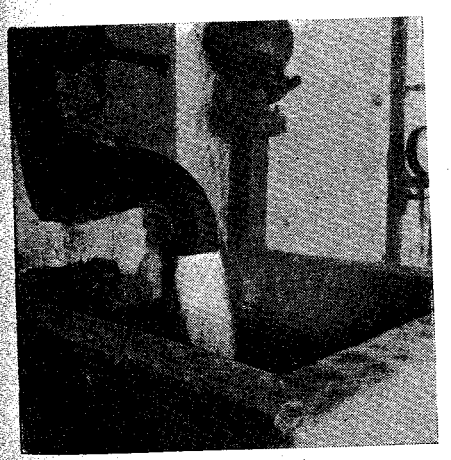
In many cases, industrial wastes and effluents cannot be gainfully utilized, and from a sanitary point of view too, their disposal sometimes becomes problematic. There is also the possibility that the accumulation in quantity of certain waste products can be derogatory to the efficient and continuous progress of that branch of industry from which they are released.

The present paper deals briefly with the effluents from Ceylon's arrack industry in which case the question of utilization appears to be secondary in importance to their disposal which takes premier place.

The Waste Liquor of Arrack Distilleries

Though a diversity of raw materials such as rice, molasses and various palm juices are used in various countries of the Orient for *arrack manufacture, yet coconut toddy forms the bed-rock of Ceylon's liquor industry. (*The term arrack is derived from the Arabic word " araq " meaning " sweat " or " juice," and is now mainly a generic term used to denote a particular spirituous beverage.

The Excise statistics for 1952, show that 214,970 coconut trees had been licensed for arrack production, and the actual volume of toddy handled by nine different distilleries during that year is given as 8,022,396 gallons.



'Spent wash' being discharged from an Arrack Still.

In usual distillery practice, where pot stills are employed, on an average only about one-fifth of the total charge of toddy is actually distilled over as spirits. The balance four-fifths left in the stills are rejected as spent wash or " pot ale." Computing on the basis of this fractionation, the total volume of effluents corresponding to the above gallonage of toddy will be found to be 6,417,917 or roughly 6·5 million gallons.

Nature of Raw Material

Before considering the composition of these effluents it would be best to have a reasonably clear idea of the nature of the raw material itself.

Coconut toddy in its unfermented state is a liquid

containing, as its essential constituent, between 12 and 18 per cent. of cane sugar (sucrose) and in its fresh state, it is usually referred to as "sweet toddy." This sap, if carefully collected in sterile glass vessels, will remain unchanged for a considerable time. As usually drawn however, it rapidly becomes infected with bacteria and yeasts collected from its surroundings and within about 24 hours the sugar present is converted into 5 to 8 per cent. by volume of alcohol (along with a small quantity of acetic acid).

Toddy that has reached this initial stage of fermentation is best suited for the manufacture of arrack; stale toddy will reduce the yield of arrack besides contaminating it with volatile acetic acid. The following figures will show the difference in average composition between the fresh sap, the fermented juice and stale toddy:—

	Sweet toddy (gms/100 ml.)	Fermented toddy (gms/100 ml.)	Stale toddy (typical) (gms/100 ml.)
Total solids	18·7	4·5*	4·4*
Acidity (as acetic)	trace	0·6	1·6
Alcohol (v/v)	nil	7·5	6·5
Ash	0·40	0·40	0·40
Sucrose	16·5	—	—

*Including any unfermented sucrose.

Nature of Effluents

The process of arrack distillation is one of concentrating alcohol by separating it as vapour from the watery base and then condensing the vapour. It will therefore be obvious, that during distillation only the volatile constituents in toddy are removed whilst the rest are left behind in the spent wash. It will also be legitimate to infer that the concentration of the non-volatile components of toddy will be slightly higher in the effluents than in the raw material, because only about one-fifth of the original bulk is usually removed as spirits by distillation.

In this connection it might be appropriate to refer to the results of chemical analyses of three typical samples of toddy spent wash recently examined by the writer.

ANALYTICAL DATA ON THREE SAMPLES OF TODDY SPENT WASH

Constituents (Gms/100 ml.)	Sample I	Sample II	Sample III	Mean	Mean % on Total Dried Solids	Mean Percentage on Ash
Solids in Suspension ...	0·609	0·362	0·373	0·45	—	—
Solids in Solution ...	1·99	2·04	2·18	2·07	—	—
Total Solids ...	2·60	2·40	2·55	2·52	—	—
Total acidity as Acetic ...	0·37	0·57	0·71	0·55	—	—
Total Sulphated Ash ...	0·67	0·64	0·65	0·65	25·8	—
% Water Soluble Ash ...	85·05	84·89	91·38	87·11	—	—
% Water Insoluble Ash ...	14·95	15·11	8·62	12·89	—	—
Potash as K_2O ...	0·171	0·163	0·178	0·171	6·79	26·3
Nitrogen ...	0·059	0·053	0·046	0·053	2·10	—
Protein (N × 6·25) ...	0·369	0·331	0·288	0·329	13·06	—
Phosphate as P_2O_5 ...	0·023	0·021	0·019	0·021	0·83	3·23

Owing to inadequacy of the samples received for examination, the waste liquor was not tested for alcohol or fermentable sugar. It should however be a reasonable assumption that typical samples of spent wash would not contain any appreciable amounts of residual alcohol or sugar.

Possible Utilization of Effluents

Though these analytical characteristics do not reveal the practicability of recovering anything commercially profitable, yet the mineral constituents of this waste doubtlessly impart to it some manurial value.

Computing on the basis of the analytical results, quoted above, it will be found that 1,000 gallons of spent wash would contain 5·3 lbs. nitrogen, 17·1 lbs. potash (as K_2O) and 2·1 lbs. phosphorus (as P_2O_5). Based on current prices of nitrogenous potassic and phosphatic fertilizers the total value of the manurial constituents present in every 1,000 gallons will be found to work out to approximately eleven rupees.

Even though these constituents are present in small concentrations, technically their recovery could not be regarded as an impossibility. With regard to potash for example though it is not possible to separate or concentrate this by sedimentation (as all potash salts are soluble), yet it can be done by evaporating off the water and concentrating the product. This process, however, would obviously cost much more than the value of the potash recovered. Similarly, it should be feasible to separate the phosphates as calcium phosphate by the addition of lime. With reference to nitrogen, sedimentation of the wash with the aid of Hyflo-supercel might result in a product containing some nitrogen, since this is partly present in the spent wash as albuminous substances. The chief obstacle against all these possibilities is the economic consideration, because the recovery of the salts would scarcely repay the cost of fuel. Also, the processing costs involved in treating eleven rupees worth of manurial constituents should in proportion be fantastic and would indeed prove to be an absurd proposition.

If we consider the fact, that there is no real need to isolate the various manurial constituents, then a practicable proposition for the economic utilization of this waste appears to be its direct application to coconut palms. In doing so, however, it would be essential to treat the spent wash with lime in order to reduce its acidity.

The spent liquor could be returned to the topes (tapping groves) in the original barrels, which brought the toddy to the distilleries, or alternatively it could be pumped into elevated tanks and distributed through pipe lines, for application to coconut palms growing in gardens or estates, adjacent to the distilleries.

At the normally prescribed rates of fertilizer application to coconut palms viz., 3 lbs. sulphate of ammonia, 2 lbs. muriate of potash and 2 lbs. saphos phosphate per palm every two years, it will be found that the calculated equivalent of these in gallons spent wash will be as follows :—

3 lbs. sulphate of ammonia	≡ 116·4 gallons of liquor
2 lbs. muriate of potash	≡ 70·0 ,, ,,
2 lbs. saphos phosphate	≡ 279·7 ,, ,,

In round figures, if the liquor could be applied to palms at the rate of approximately 60 gallons per palm per year, this should cover all the nitrogen requirements of the palm, besides providing almost a luxury double dose of potash which is well known to be the dominant fertilizer requirement of the coconut. The palms treated this way should require to be supplemented only with phosphates to the extent of about 0·5 lb. saphos phosphate per year.

Toddy Yeasts

The foam and 'top yeast' being skimmed off from a fermenting vat.

In discussing the nature and composition of the raw material and the utilization of the effluents, reference has not been made to the yeasts present in toddy. As alcoholic fermentation is essentially a chemico-physiological process, fermented toddy is inevitably associated with yeasts. These are living vegetable micro-organisms of wonderful activity and usefulness. The yeast cell itself being a manufacturing plant of marvellous efficiency and productivity. In the fermentation industries yeasts are classified into top and bottom varieties but actually the groups are not in any way sharply separated or defined. Though the individual cells are microscopic structures, yet the yeasts in a fermenting vat of toddy could be collected in the form of a creamy sediment either by skimming off the foam or froth on top (usually referred to as "head" in fermentation industries), or by scooping the bottom of the vat.

On the basis of certain preliminary laboratory studies it has been found that on an average a recovery of approximately one pound of dried yeast could be made from every 200 gallons of fermented toddy used for arrack production. It could however be anticipated that under conditions of commercial production the yields would be very variable. In Ceylon distillery practice, toddy yeasts are just run to waste with the effluents. If they are recovered and dried they could very well be regarded as a protein concentrate, most valuable as food for farm-stock, especially when mixed with other feeding stuffs such as grain or oil-cake. In certain countries notably the West Indies, the manufacture of dried yeast, compressed yeast and yeast foods comprise a considerable industry.

Disposal of Effluents

In general, the question of disposal of large bulks of effluents like spent wash is always a difficult one. At present, there are ten arrack distilleries in the Island, nine of them being under private management and one under State ownership. As no means of utilization have yet been devised, it is usual for each factory to run out daily as much as 3,000 to 5,000 gallons or more, of spent wash as waste, into nearby streams.

The uncontrolled discharge of waste liquors into rivers and surface waters in many cases renders them unsuitable for industrial or agricultural uses, besides creating problems of grave magnitude sometimes for the Sanitary and Health authorities. With the growth of towns and the growth of concentration of industry in industrial districts, pollution of water by effluents readily facilitates the transmission of water-borne diseases. There is evidence, that in certain parts of the Island the medical authorities have already raised objections on these grounds.

The analytical figures quoted above, show that the spent wash of arrack distilleries contains a considerable amount of organic matter indicated by the concentration of total solids and nitrogen. A separate experiment has also shown that this organic matter could be readily decomposed by biological action. In other words, if the streams or rivers into which the effluents are discharged do not permit of requisite dilution then severe deoxygenation of the water could result giving ris

erobic conditions with concomitant danger to the survival of any living organisms including fish in the water. In view of these hazards, it is not improbable that at a future date legislation may be introduced whereby the discharge of toddy effluents (especially into small streams and water courses) is forbidden. In such an eventuality, distillery authorities would be compelled to resort to alternative methods for the disposal of these effluents.

Conclusion

Since the production of alcoholic beverages is one of the oldest known industries, an enormous amount of empirical information has been built up through the centuries. Ceylon's arrack industry too is fairly well established now, and undoubtedly a large body of data has now accumulated on the method of arrack-manufacture using coconut toddy as source material. This alone, cannot be regarded as a satisfactory index of a successful industry. An industrial effluent constitutes an integral part of the industry from which it has been released and so long as the problem of its disposal and rational utilization has not been solved, there should be no room for complacency. In the context of modern times, it is more than ever necessary to give careful attention to what may at the present time appear to be valueless.

It is true that no rich treasures like the beautiful dyes or the perfumes and essences derived from a repulsive substance like coal tar are to be found in toddy effluents. It is however incumbent on those interested and closely associated with the industry to make every effort to evolve an economical and practicable method for the utilisation and disposal of these waste liquors.

The writer has endeavoured to elucidate the possible uses of the waste effluents of distilleries, besides adducing reasons to show that its satisfactory disposal is a matter of national importance.