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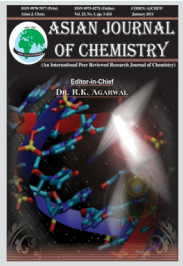

# Impact of Irrigation of Distillery Spentwash on the Nutrients of Herbal Medicinal Plants

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Cultivation of some herbal medicinal plants was made by irrigation with distillery spent wash of different concentrations. The spent wash *i.e.*, primary treated spent wash, 33 and 50 % spent wash were analyzed for their plant nutrients such as nitrogen, phosphorous, potassium and other physical and chemical characteristics. Experimental soil was tested for its chemical and physical parameters. Seeds of herbal medicinal plants were sowed in the prepared land and irrigated with raw water, 33 and 50 % spent wash. The impact of distillery spent wash on proximate principles (moisture, protein, fat, fibre, carbohydrate, calcium, phosphorous, iron and energy), vitamin content (carotene and vitamin-C), mineral and trace elements (magnesium, sodium, potassium, copper, manganese, zinc, chromium and nickel) of herbal medicinal plants were investigated. It was found that the uptake of nutrients of all herbal medicinal plants in case of 33 % spent wash irrigation when compared with 50 % spentwash and raw water irrigations.

**Key Words: Distillery spent wash, Herbal medicinal plants, Nutrients, Proximate principles, Harvest.**

## INTRODUCTION

Molasses (one of the important byproducts of sugar industry) is the chief source for the production of ethanol in distilleries by fermentation method. About 8 L of wastewater is discharged for every liter of ethanol production in distilleries, known as raw spent wash (RSW), which is characterized by high biological oxygen demand (BOD: 5000-8000 mg/L) and chemical oxygen demand (COD: 25000-30000 mg/L), undesirable colour and foul smell[1]. Discharge of raw spent wash into open land or near by water bodies is a serious problem since it results in a number of environmental, water and soil pollution including threat to plant and animal lives. The RSW is highly acidic and contains easily oxidizable organic matter with very high BOD and COD[2]. Also, spent wash contains high organic nitrogen and nutrients[3]. By installing biomethenation plant in distilleries, reduces the oxygen demand of RSW, the resulting spent wash is called primary treated spent wash (PTSW) and primary treatment to RSW increases the nitrogen, potassium and phosphorous contents and decreases the calcium, magnesium, sodium, chloride and sulphate[4]. The PTSW is rich in potassium, sulphur, nitrogen, phosphorous as well as easily biodegradable organic matter and its application to soil has been reported to increase yield of sugar cane[5], rice[6], wheat and rice[7], quality of groundnut[8] and physiological response of soybean[9]. Diluted spent wash could be used for irrigation purpose without adversely affecting soil fertility[10-12], seed germination and crop productivity[13]. The diluted spent wash irrigation improved the physical and chemical properties of the soil and further increased soil microflora[10,11,14]. Twelve pre-sowing irrigations with the diluted spent wash had no adverse effect on the germination of maize but improved the growth and yield[15]. Diluted spent wash increases the growth of shoot length, leaf number per plant, leaf area and chlorophyll content[16] of peas. Increased concentration of spent wash causes decreased seed germination, seedling growth and chlorophyll content in sunflowers (*Helianthus annuus*) and the spent wash could safely used for irrigation purpose at lower concentration[13,17]. The spent wash contained an excess of various forms of cations and anions, which are injurious to plant growth and these constituents should be reduced to beneficial level by diluting the spent wash, which can be used as a substitute for chemical fertilizer[18]. The spent wash could be used as a complement to mineral fertilizer to sugarcane[19]. The spent wash contained N, P, K, Ca, Mg and S and thus valued as a fertilizer when applied to soil through irrigation with water[20]. The application of diluted spent wash increased the uptake of zinc, copper, iron and manganese in maize and wheat as compared to control and the highest total uptake of these were found at lower

dilution levels than at higher dilution levels[21]. Mineralization of organic material as well as nutrients present in the spent wash was responsible for increased availability of plant nutrients[22]. Diluted spent wash increase the uptake of nutrients, height, growth and yield of leafy vegetables[23-26], nutrients of cabbage and mint leaf[27], nutrients of top vegetable[28], pulses[29], condiments, root vegetables[30] and yield of condiments[31]. However, not much information is available on the influence of distillery spent wash irrigation on the nutrients of herbal medicinal plants. Therefore, the present investigation was carried out to study the influence of different proportions of spent wash on the nutrition of herbal medicinal plants.

## EXPERIMENTAL

Field work was conducted at land in Duddagere village near Mysore, Mysore Dt., Karnataka. Before cultivation, a composite soil sample was collected from the experimental site at 25 cm depth at different parts, mixed and dried under sunlight. The sample was analyzed by standard procedures (Table-1). The PTSW was used for irrigation with a dilution of 33 and 50 %. The physical and chemical characteristics and amount of nitrogen, potassium, phosphorous and sulphur present in the PTSW, 33 and 50 % distillery spent wash were analyzed using standard procedures (Tables 2 and 3).

Herbal medicinal plants selected for the present investigation were, tulsi (*Ocimum sanctum*), kama kasturi (*Ocimum basilicum*), thumbe (*Leucas aspera*). The seeds/sets were sowed and irrigated (by applying 5-10 mm/cm$^2$ depends upon the climatic condition) with raw water, 33 and 50 % spent wash at the dosage of twice a week and rest of the period with raw water as required. Trials were conducted for three times and at the time of maturity, plants were harvested and proximate principle, vitamins, minerals and trace elements were analyzed (Table-4).

## RESULTS AND DISCUSSION

Characteristics of experimental soils such as pH, electrical conductivity, the amount of organic carbon, available nitrogen, phosphorous, potassium, sulphur, exchangeable calcium, magnesium, sodium, DTPA iron, manganese, copper and zinc were analyzed and tabulated (Table-1). It was found that the soil composition is fit for the cultivation of plants, because it fulfils all the requirements for the growth of plants.

Chemical composition of PTSW *i.e.*, 33 and 50 % spent wash such as pH, electrical conductivity, total solids, total dissolved solids, total suspended solids, settelable solids, chemical oxygen demand, biological oxygen demand, carbonates, bicarbonates, total phosphorous, total potassium, ammonical nitrogen, calcium, magnesium, sulphur, sodium, chlorides, iron, manganese, zinc, copper, cadmium, lead, chromium and nickel were analyzed and tabulated (Table-2). Amount of N, P, K and S contents are presented in Table-3.

In the case of all leafy medicinal plants, uptake of all the parameters were very good in both 33 and 50 % spent wash as compared to raw water. In both 33 and 50 % spent wash irrigation, the uptake of the nutrients such as fat, calcium, zinc, copper and vitamins carotene and vitamin c were almost similar but the uptake of the nutrients and parameters such as protein,

TABLE – 1
CHARACTERISTICS OF EXPERIMENTAL SOIL

| Parameters | |
|---|---|
| Coarse sand (%) | 9.85 |
| Fine sand (%) | 40.72 |
| Slit (%) | 25.77 |
| Clay (%) | 23.66 |
| pH (1:2 soln) | 8.41 |
| Electrical conductivity (µS) | 540.00 |
| Organic carbon (%) | 1.77 |
| Available nitrogen (mg/L) | 402.00 |
| Available Phosphorous (mg/L) | 202.00 |
| Available Potassium (mg/L) | 113.00 |
| Exchangeable Calcium (mg/L) | 185.00 |
| Exchangeable Magnesium (mg/L) | 276.00 |
| Exchangeable Sodium (mg/L) | 115.00 |
| Available Sulphur (mg/L) | 337.00 |
| DTPA Iron (mg/L) | 202.00 |
| DTPA Manganese (mg/L) | 210.00 |
| DTPA Copper (mg/L) | 12.00 |
| DTPA Zinc (mg/L) | 60.00 |

TABLE-2
CHEMICAL CHARACTERISTICS OF DISTILLERY SPENTWASH AT DIFFERENT DILUTION

| Chemical parameters | PTSW | 33 % PTSW | 50 % PTSW |
|---|---|---|---|
| pH | 7.57 | 7.65 | 7.63 |
| Electrical conductivity (µS) | 26400 | 7620 | 17260 |
| Total solids (mg/L) | 47200 | 21930 | 27230 |
| Total dissolved solids (mg/L) | 37100 | 12080 | 18000 |
| Total suspended solids (mg/L) | 10240 | 4080 | 5380 |
| Settleable solids (mg/L) | 9880 | 2820 | 4150 |
| COD (mg/L) | 41250 | 10948 | 19036 |
| BOD (mg/L) | 16100 | 4700 | 7718 |
| Carbonate (mg/L) | Nil | Nil | Nil |
| Bicarbonate (mg/L) | 12200 | 3300 | 6500 |
| Total phosphorous (mg/L) | 40.5 | 17.03 | 22.44 |
| Total potassium (mg/L) | 7500 | 2700 | 4000 |
| Calcium (mg/L) | 900 | 370 | 590 |
| Magnesium (mg/L) | 1244.16 | 134.22 | 476.16 |
| Sulphur (mg/L) | 70 | 17.8 | 30.2 |
| Sodium (mg/L) | 520 | 280 | 300 |
| Chloride (mg/L) | 6204 | 3404 | 3512 |
| Iron (mg/L) | 7.5 | 3.5 | 4.7 |
| Manganese (mg/L) | 980 | 288 | 495 |
| Zinc (mg/L) | 1.5 | 0.63 | 0.94 |
| Copper (mg/L) | 0.25 | 0.048 | 0.108 |
| Cadmium (mg/L) | 0.005 | 0.002 | 0.003 |
| Lead (mg/L) | 0.16 | 0.06 | 0.09 |
| Chromium (mg/L) | 0.05 | 0.012 | 0.026 |
| Nickel (mg/L) | 0.09 | 0.025 | 0.045 |
| Ammonical nitrogen (mg/L) | 750.8 | 283.76 | 352.36 |
| Carbohydrates (%) | 22.80 | 8.12 | 11.56 |

PTSW = Primary treated distillery spentwash

TABLE-3
AMOUNT OF N, P, K AND S (NUTRIENTS) IN DISTILLERY SPENTWASH

| Chemical parameters | PTSW | 33 % PTSW | 50 % PTSW |
|---|---|---|---|
| Ammonical nitrogen (mg/L) | 750.8 | 283.76 | 352.36 |
| Total phosphorous (mg/L) | 40.5 | 17.03 | 22.44 |
| Total potassium (mg/L) | 7500 | 2700 | 4000 |
| Sulphur (mg/L) | 70 | 17.8 | 30.2 |

PTSW = Primary treated distillery spentwash

TABLE-4
NUTRITIVE VALUES OF HERBAL MEDICINAL PLANTS AT DIFFERENT IRRIGATION SYSTEM

| Parameters | Tulsi (*Ocimum sanctum*) | | | Kama kasturi (*Ocimum basilicum*) | | | Thumbe (*Leucas aspera*) | | |
|---|---|---|---|---|---|---|---|---|---|
| | RW | 33 % SW | 50 % SW | RW | 33 % SW | 50 % SW | RW | 33 % SW | 50 % SW |
| Moisture (g) | 12.0 | 12.8 | 12.3 | 90.96 | 90.98 | 90.98 | – | – | – |
| Fat (g) | 0.64 | 0.8 | 0.69 | 0.61 | 0.64 | 0.62 | 0.08 | 0.09 | 0.085 |
| Acid insoluble ash (g) | 0.4 | 0.45 | 0.45 | 0.25 | 0.28 | 0.27 | 0.25 | 0.26 | 0.26 |
| Protein (g) | 2.9 | 3.2 | 3.0 | 2.54 | 3.15 | 3.0 | 0.4 | 0.62 | 0.57 |
| Fibre (g) | 1.60 | 1.8 | 1.7 | 1.60 | 3.9 | 2.5 | 0.3 | 0.33 | 0.32 |
| Carbohydrate (g) | 2.65 | 5.0 | 3.25 | 2.0 | 4.62 | 2.65 | 5.2 | 6.0 | 5.8 |
| Energy (kCal) | 23.0 | 40.0 | 32.0 | 23.0 | 27.0 | 25.0 | 20.0 | 26.0 | 23.0 |
| Calcium (mg) | 177.0 | 185.0 | 180.0 | 154.0 | 177.0 | 165.0 | 40.0 | 56.0 | 45.0 |
| Magnesium (mg) | 60.0 | 67.0 | 63.0 | 64.0 | 81.0 | 72.0 | 8.0 | 16.5 | 13.0 |
| Sodium (mg) | 4.0 | 8.0 | 8.0 | 14.0 | 25.0 | 18.0 | 20.0 | 24.0 | 23.0 |
| Potassium (mg) | 250.0 | 295.0 | 280.0 | 295.0 | 462.0 | 368.0 | 8.0 | 9.2 | 8.5 |
| Iron (mg) | 3.85 | 8.0 | 6.0 | 3.17 | 3.18 | 3.18 | 0.3 | 0.39 | 0.32 |
| Phosphorous (mg) | 30.0 | 38.0 | 35.0 | 29.0 | 69.0 | 40.0 | 25.0 | 28.0 | 26.0 |
| Zinc (mg) | 0.25 | 0.81 | 0.58 | 0.72 | 0.85 | 0.81 | 0.15 | 0.23 | 0.2 |
| Manganese (mg) | 0.25 | 1.15 | 0.59 | 1.15 | 1.45 | 1.32 | 0.10 | 0.1 | 0.1 |
| Copper (mg) | 0.08 | 0.9 | 0.09 | 0.19 | 0.385 | 0.29 | 0.09 | 0.13 | 0.10 |
| Chlorides (mg) | 65 | 0.72 | 0.70 | 25 | 35.0 | 30.0 | 20.0 | 27.0 | 24.0 |
| Lead (mg) | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| Cadmium (mg)) | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| Chromium (mg) | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Nickel (mg) | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Sulphur (mg) | 100.0 | 110.0 | 108.0 | 10.0 | 20.0 | 15.0 | 15.0 | 19.0 | 18.0 |
| Carotene (µg) | 3100 | 3150 | 3125 | 80.0 | 109.0 | 100.0 | 100.0 | 148.0 | 132.0 |
| Vitamin C (mg) | 18.0 | 40.0 | 22.0 | 10.0 | 18.0 | 16.0 | 20.0 | 23.0 | 23.0 |

RW = Raw water; SW = Spentwash

fibre, carbohydrate, energy, magnesium and phosphorous were much more in the case of 33 % spent wash irrigation than 50 % and raw water irrigation (Table-4). This could be due to the more absorption of plant nutrients present in spent wash by plants. It was also found that no negative impact of heavy metals like lead, cadmium and nickel in herbal medicinal plants tulsi (*Ocimum sanctum*), kama kasturi (*Ocimum basilicum*), thumbe (*Leucas aspera*).

In conclusion, It is found that the nutrients uptake in all the herbal medicinal plants were largely influenced in case of both 33 and 50 % spent wash irrigation than with raw water. But 33 % distillery spent wash shows more uptakes of nutrients when compared to 50 % spent wash in all leafy medicinal plants. This could be due to the maximum absorption of nutrients by plants at highly diluted conditions.

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