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APPRAISAL OF TRANSFER OF NA CONCENTRATION IN PLANT AND CHICKEN VIA DIFFERENT WATER REGIMES

Dr. Zill-E-Huma[1], Muhammad Jawad Umar[2], Noman Nasir[3], Muhammad Usman Ghani[4], Dr. Asif Abbas Shah[5], Hifza Jabeen[6], Muhammad Bilal Malik[7], Dr. Abid Ejaz[8], Dr. Sajid Mahmood[*9], Dr. Mian Jahan Zaib Rasheed[10]

[1,8,10]*Department of Botany, University of Sargodha, Sargodha, Pakistan*
[2]*Department of Chemistry, Quaid-e-Azam University, Islamabad, Pakistan*
[3]*Department of Zoology, University of Sargodha, Sargodha, Pakistan*
[4]*Department of Botany, University of Agriculture Faisalabad, Punjab, Pakistan*
[5]*Department of Botany University of Sargodha, Sargodha, Pakistan*
[6]*Department of Zoology, University of Agriculture Faisalabad, Pakistan*
[7]*Department of Biological Sciences, University of Lahore, Sargodha Campus, Pakistan.*
[*9]*Department of Zoology, Hazara University Mansehra, Pakistan*

[1]humashah690@gmail.com, [2]jawadumarsaggu@gmail.com, [3]nomangillkhb@gmail.com, [4]rana11766@gmail.com, [5]aasgd86@gmail.com, [6]hifzajabeen612@gmail.com, [7]muhammadbilalmalik8485@gmail.com, [8]abid155yahoo.com, [*9]sajid_sbs12@hu.edu.pk, [10]jahanzaibrasheedgc@gmail.com

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Corresponding Author: *
Dr. Sajid Mahmood

Abstract
Water scarcity in agriculture sector enforced farmers to apply city wastewater without any regard of its quality effects on environment and consequential pollution of soils and plants and animals, dependent on these plants, particularly with heavy metals. The main purpose of this research was to appraise the level of Na in tissues of chicken that were reared on grains of maize crop treated with sewage water, canal water and ground water (SWT, CWT and GWT). Samples were assayed for Na contents. Therefore, in order to reduce the health risk and the extent of heavy metal contamination, steps must be taken for efficient treatment of sewage. Regular monitoring of heavy metals in the vegetables grown in waste water irrigated areas is also necessary. Governments usually focus on phosphorus reduction whereas they ignore the effects of sodium in wastewater. The main source of sodium in wastewater is the use of sodium as fillers in different detergents. As a result the amount of sodium increases significantly in wastewater. The focus of this paper is to look at the concentration of of sodium in different water regimes and examine that impact of sodium rich wastewater on maize plant and chicken.

Introduction
Sodium is an essential biological chemical which takes part in processes maintaining osmotic pressure in living cells, plant and animal. An excess of sodium disturbs the critical balance and in humans excess salt (sodium chloride) intake has been linked to heart disease and high blood pressure. In plants, excess sodium leads to a perceived drought effect and plants will show “burnt edge” effects and eventually die. Salt

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tolerance is a characteristic of many plants but for agronomic purposes, including landscaping and wastewater reuse options, significant losses in plant quality and production arise from increased sodium in the plants' environment. Animals are tolerant to larger concentrations of sodium. It is common for sheep and cattle to eat soil, scraping the hard soil with their teeth, where salt extrusions occur along gully lines. Many animals also prefer salty ground water to clean rainwater.

Results for Na

Water

Analysis of variance of data for Na concentration in water showed that there was a significant difference in Na concentration in all sources of water (Table 10).

Table 10; Analysis of variance for sodium in ground water, sewage water and canal water

Source of variations (Sov)	Degree of freedom (df)	Sodium
Source	2	24.5797*
Error	6	3.9276

ns= Non-significant; *= Significant at 0.05 levels

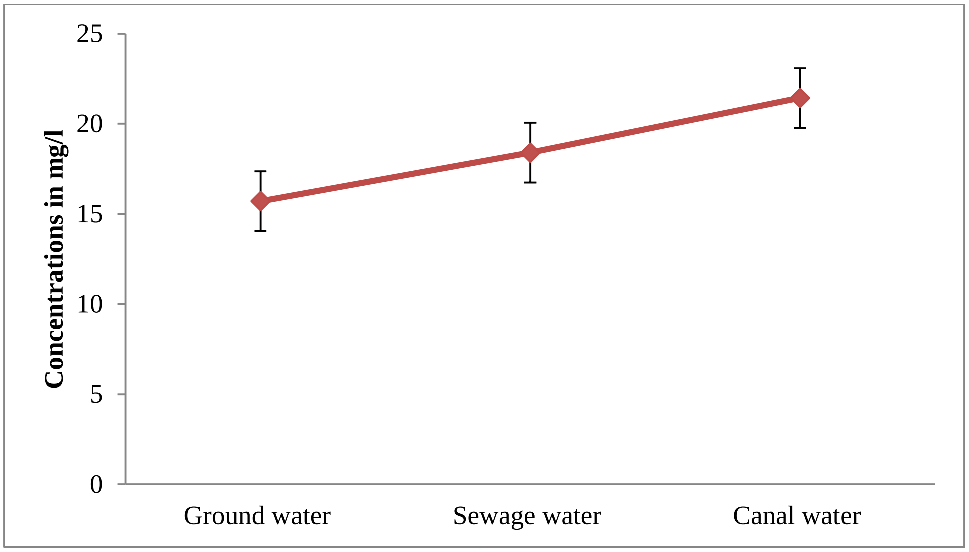

Fig. 10; Concentration of sodium in ground water, sewage water and canal water

Concentration of sodium in soil

Analysis of variance of data for Na concentration in soil showed that there was a significant difference in Na concentration in soil in both seasons (Table 10.1).

Table 10.1; Analysis of variance for sodium in soil (mg/kg) irrigated with ground water, sewage water and canal water

Source of variations (Sov)	Degree of freedom (df)	Experiment 1 (Spring season)	Experiment 2 (Autumn season)
Source	2	27.6280**	30.3846**
Error	6	1.6591	0.4013

ns= Non-significant; **= Significant at 0.01 levels

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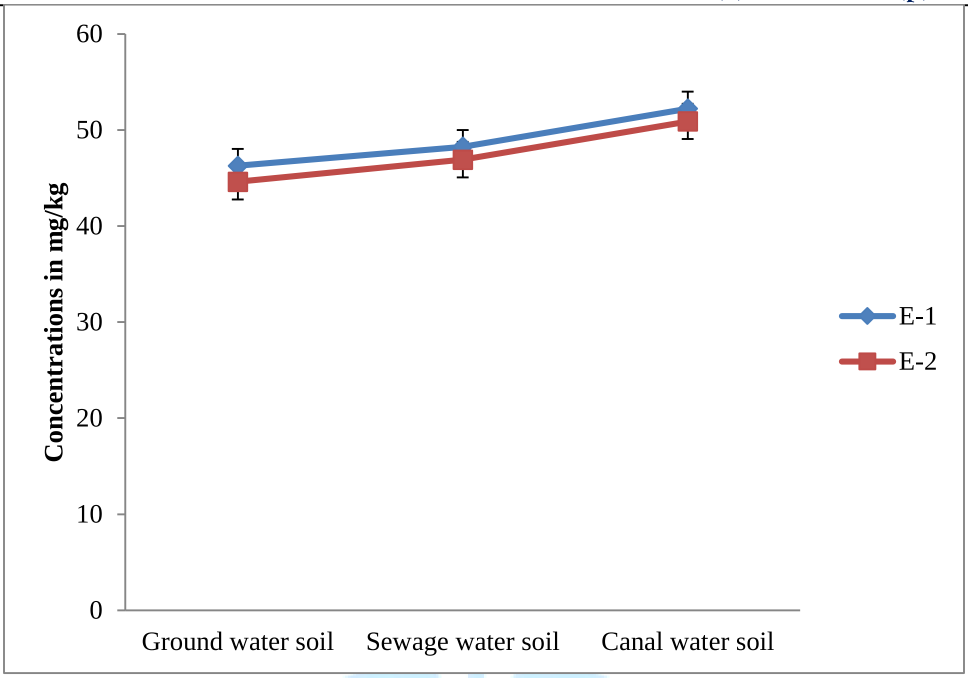

Fig. 10.1; Concentration of sodium in soil irrigated with ground water, sewage water and canal water

Concentration of sodium in plant

Season, variety and treatment significantly affected the concentration of Na in all parts of the plant. Season×Variety and Variety×Treatment interaction was significant in all plant parts but Season×Treatment and Season×Variety×Treatment interaction was non-significant in shoot (Table, 10.2).

Grains

In experiment 1 (Spring season), the highest (5.10±0.00) level of Na for grains was found in Sadaf variety at canal water treatment and the lowest (2.87±0.00) concentration of Na was found in grains of Sadaf variety at ground water treatment. In experiment 2 (Autumn season), the maximum level of Na (5.97±0.02) was found in grains of Pearl variety at sewage water treatment and the lowest (3.23±0.04) concentration of Na was found in Sadaf variety at ground water treatment (Fig. 10.2).

Shoot

In experiment 1 (Spring season), the highest (9.78±0.05) level of Na for shoot was found in MMRI variety at canal water treatment and lowest (4.27±0.32) concentration of Na was found in shoot of Pearl variety at ground water treatment. In experiment 2 (Autumn season), the maximum level of Na (11.20±0.22) was found in shoot of MMRI variety at canal water treatment and the lowest (5.16±0.09) concentration of Na was found in Pearl variety at ground water treatment (Fig. 10.2).

Root

In experiment 1 (Spring season), the highest (8.00±0.00) level of Na for root was found in Sadaf variety at canal water treatment and the lowest (2.18±0.00) concentration of Na was found in root of MMRI variety at ground water treatment. In experiment 2 (Autumn season), the maximum level of Na (8.43±0.23) was found in root of Sadaf variety at canal water treatment and the lowest (2.42±0.13) concentration of Na was found in Sahiwal-2002 variety at ground water treatment (Fig.10.2).

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Table 10.2; Analysis of variance of data for grains, shoot and root of four varieties of corn differing in concentrations of Na grown in pots under diverse irrigation regimes in both experiments conducted in varying seasons

Source of variations	Degree of freedom	Grains	Shoot	Root
Season	1	7.9335**	12.0042**	12.7193**
Variety	3	0.8695**	11.8674**	16.0842**
Treatment	2	11.4023**	58.818**	97.981**
S×V	3	1.1704**	0.6152**	0.8847**
S×T	2	0.4541**	0.1303ns	1.5137**
V×T	6	1.6161**	6.0524**	5.0702**
S×V×T	6	0.5075**	0.1218ns	0.9186**
Error	48	0.0055	0.0547	0.0231

**= Significant at 0.01 levels

S, Seasons; **V,** variety; **T,** treatment, S×V, season into variety interaction; S×T, season into treatment interaction; V×T, Variety into treatment interaction; S×V×T, season into variety into treatment interaction; ns= Non-significant

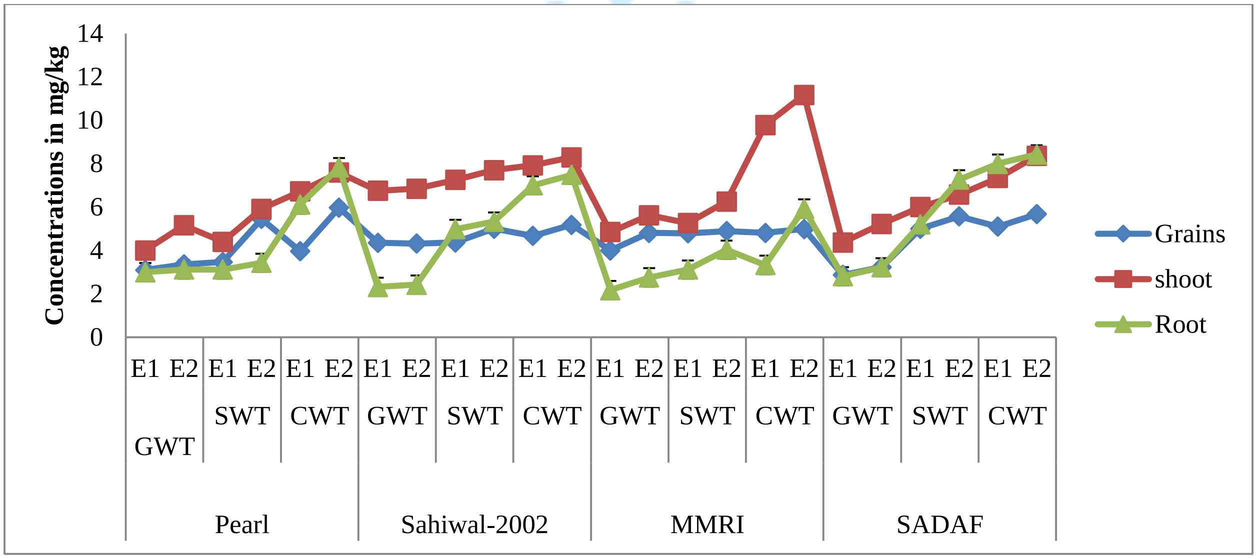

Fig. 10.2; Sodium concentration (mg/kg) in plant parts of different varieties underground (GWT), sewage (SWT) and canal water treatment (CWT) in both experiments conducted in varying seasons

Distribution of sodium in the body parts of chicken

Season, variety and treatment significantly affected the concentration of Na in all parts of chicken. Season×Variety interaction was significant in all parts of the animal. Season×Treatment interaction was non-significant in liver, Variety×Treatment interaction was non-significant in bone and liver and Season×Variety×Treatment interaction was non-significant in bone, meat and liver (Table 10.3).

Blood

In experiment 1 (Spring season), the maximum concentration of Nafor blood (5.00±0.00) was in chicken that used Sahiwal-2002 variety grains raised with canal water in their diet and the minimum level was found in blood (1.76±0.15) of the chicken that used Sadaf variety grains raised with ground water in their diet. In experiment 2 (Autumn season), the highest concentration of Nawas found in the blood (5.94±0.04) of chicken that utilized Pearl variety

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grains raised with canal water as their diet and the lowest (2.75±0.04) was found on the utilization of the Pearl variety grains raised with ground water (Fig. 10.3).

Bone

In experiment 1 (Spring season), the maximum concentration of Na for bone (9.15±0.05) was in chicken that used Sadaf variety grains raised with canal water in their diet and the minimum level was found in bone (7.10±0.10) of the chicken that used Pearl variety grains raised with ground water in their diet. In experiment 2 (Autumn season), the highest concentration of Na was found in the bone (23.89±2.10) of chicken that utilized Sahiwal-2002 variety grains raised with canal water as their diet and the lowest (14.13±0.13) was found on the utilization of the MMRI variety grains raised with ground water (Fig. 10.3).

Breast meat

In experiment 1 (Spring season), the maximum concentration of Na for meat (5.15±0.32) was in chicken that used Sahiwal-2002 variety grains raised with canal water in their diet and the minimum level was found in meat (2.58±0.42) of the chicken that used MMRI variety grains raised with ground water in their diet. In experiment 2 (Autumn season), the highest concentration of Na was found in the meat (9.79±1.00) of chicken that utilized Pearl variety grains raised with canal water as their diet and the lowest (3.36±0.53) was found on the utilization of the Sahiwal-2002 variety grains raised with ground water (Fig. 10.3).

Liver

In experiment 1 (Spring season), the maximum concentration of Na for liver (20.06±3.06) was in chicken that used Sadaf variety grains raised with canal water in their diet and the minimum level was found in liver (9.14±0.04) of the chicken that used MMRI variety grains raised with ground water in their diet. In experiment 2 (Autumn season), the highest concentration of Na was found in the liver (27.69±2.01) of chicken that utilized Pearl variety grains raised with canal water as their diet and the lowest (17.46±0.00) was found on the utilization of the MMRI variety grains raised with ground water (Fig. 10.3).

Heart

In experiment 1 (Spring season) the maximum concentration of Na for heart (5.86±0.00) was in chicken that used Pearl variety grains raised with canal water in their diet and the minimum level was found in heart (2.88±0.02) of the chicken that used Sadaf variety grains raised with ground water in their diet. In experiment 2 (Autumn season), Na maximum concentration(12.38±0.00)was observedin heart of chicken that utilized Pearl variety grains raised with canal water as their diet and the lowest (3.26±0.20) was found on the utilization of the Sadaf variety grains raised with ground water (Fig. 10.3).

Kidney

In experiment 1 (Spring season), the maximum concentration of Na for kidney (4.20±0.20) was in chicken that used Pearl variety grains raised with canal water in their diet and the minimum level was found in kidney (2.46±0.05) of the chicken that used Sahiwal-2002 variety grains raised with ground water in their diet. In experiment 2 (Autumn season), the highest concentration of Na was found in the kidney (3.79±0.10) of chicken that utilized Sadaf variety grains raised with canal water as their diet and the lowest (2.29±0.08) was found on the utilization of the Sahiwal-2002 variety grains raised with sewage water (Fig. 10.3).

Gizzard

In experiment 1 (Spring season), the maximum concentration of Na for gizzard (20.00±2.00) was in chicken that used Sahiwal-2002 variety grains raised with canal water in their diet and the minimum level was found in gizzard (7.85±0.15) of the chicken that used Sadaf variety grains raised with ground water in their diet. In experiment 2 (Autumn season),the highest concentration of Na was found in the gizzard (35.13±2.13) of chicken that utilized Sadaf variety grains raised with canal water as their diet and

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the lowest (13.07±0.06) was found on the utilization of the Sahiwal-2002 variety grains raised with ground water (Fig. 10.3).

Table 10.3; Analysis of variance of data for sodium (mg/kg) in body parts of chicken feed on corn grains raised with ground water, sewage water and canal water in two seasons

Source of variations	Degree of freedom	Blood	Bone	Meat	Liver	Heart	Kidney	Gizzard
Season	1	14.4234**	1,474.117**	18.8376**	399.821**	93.167**	0.8076**	1,359.271**
Variety	3	2.7663**	5.2926*	6.1307**	17.1353*	29.0724**	2.8972**	37.3836**
Treatment	2	5.5004**	51.732**	24.5577**	151.871**	25.0578**	0.2170**	303.476**
S×V	3	1.7230**	6.2293*	7.7178**	23.1191**	15.2142**	0.8146**	80.440**
S×T	2	0.2522**	20.8306**	5.3586**	6.5354ns	5.7213**	1.2372**	23.2943**
V×T	6	0.4201**	0.9870ns	1.7756*	10.1025ns	2.6408**	0.7341**	6.0334ns
S×V×T	6	0.5907**	1.4873ns	1.4405ns	8.3734ns	1.0785**	1.1627**	9.8991*
Error	24	0.0184	1.5528	0.5825	4.3949	0.0797	0.0140	3.1370

ns= Non-significant; ;**S,** Seasons; **V,** variety; **T,** treatment, S×V, season into variety interaction; S×T, season into treatment interaction; V×T, Variety into treatment interaction; S×V×T, season into variety into treatment interaction; *,**= Significant at 0.05 and 0.01 levels

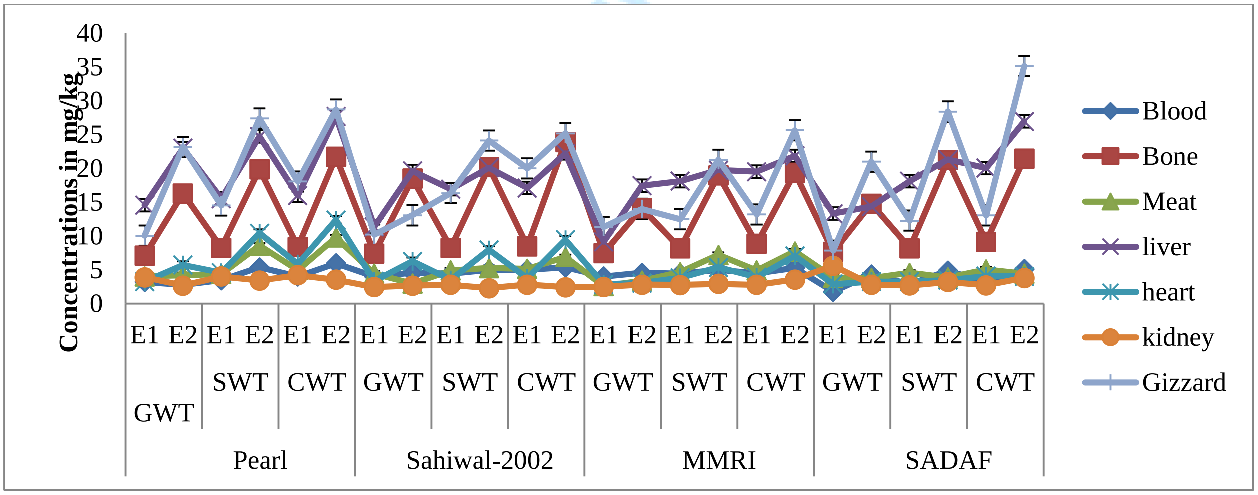

Fig. 10.3; Sodium concentration in seven body parts of the chicken in both experiments conducted in varying seasons reared on grains of different varieties irrigated with ground water (GW), Sewage water (SW) and canal water

Discussion for Na

Water

The concentration of Na was higher in canal water compared to sewage and ground water. The sodium content of water is very important to fix on its quality for irrigation; salts eventually influence the quality of soil as well as plant growth (Pandit et al., 2005). Excess amounts of main dissolved ions are responsible for salinization of the soil. Sodium is chiefly

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hazardous when used to irrigate heavy clay soils since it decreases the stability of the soil particles and causes physical degradation, which is known as sodicity. Calcium and magnesium counteract sodicity in case of water use for irrigation (Gupta and Gupta, 1999). The current research values were partly comparable to those found by Aftab et al., (2011) who studied the pollution status of Lahore branch canal determined by physical, chemical and metal constituents for the reason that the water is used for irrigation purposes of lands in as well as around the city. Sodium in our diets results mainly from eating table salt found within many food products. Sodium in drinking water normally presents no health risks, as about 99 percent of the daily salt intake is from food and only about one percent from water. However, elevated sodium in well water may be considered a health concern for those on a salt restricted diet. Individuals on a low sodium diet due to a high blood pressure or other medical problems are often restricted to water containing less than 20 milligrams per liter of sodium (Juned and Arjun, 2011). The maximum permissible limit of sodium is 200 mg/l (WHO, 2004; ISI, 1993) and all water samples in current research were within safe limits. Soil samples in present research showed the higher concentration of Na in canal water irrigated soil. The results were in line with those found by Ismail et al., (2014) who found the higher concentration of different metals in canal water and canal water irrigated soil compared to waste water and tubewell water irrigated soil samples however opposite to those found by Shad et al., (2014). They found the higher concentration of Metals along with Na in sewage water compared to canal water.

PLANT

In current research canal water irrigated parts showed the higher concentration of Na compared to other plant parts as canal water and canal water irrigated soil contained the higher concentration of Na in it. Current research values for Na were partly similar to those found by Haroon et al., 2014 who conducted an experiment to compare the level of macro elements (P, Na and K) in edible part of the twelve different species of vegetables, irrigated with three different water sources. They found the following order for accumulation of macro elements (Na, P and K) in the edible part of plants sewage > canal > tube well water which was opposite to that found in present research for Na that was canal> sewage> ground.

Animal

Salts can usually contribute to the mineral necessity of poultry though their occurrence is usually not considered when guesstimates of requirements are made , (Ross 1979) however, many minerals can prove toxic if they are present at higher level and results in reduction in laying performance and growth can occur. Biological reactions to minerals may differ depending whether they are present in drinking water or the diet.

There are two main sources from which farm animals can derive their mineral nutrients that is the feeds and the inorganic compounds of industrial or geological origin that are accessible as supplements to these feeds. Sodium is an essential element for animals; the body contains approximately 0.2 % of sodium. About one – quarter of this amount is localized in the skeleton in an insoluble rather inert form, but the balance was found in the extra cellular fluids where it undergoes a very active metabolism.

In current research the higher concentration of Na was seen in the group of chicken that utilized the CWT grains in their diet and the least was observed in the group that feed on GWT grains. (Ross 1979) reported that the Na requirement of broiler chicks fed a wheat soyabean diet was greater than the 0.15 % suggested by NRC when the water Na was 3 ppm. In the complete absence of Na in their diets, adding up of 50 ppm of Na to the drinking water considerably improved growth and feed efficiency, when 100 ppm of Na was added to the drinking water, growth was corresponding to that of birds getting the basal diet to which Na was supplemented up to 0.15 %. Ross concluded that Na in the feed was not as such effective compared to Na in drinking water.

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