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*Original Research Article*

# Estimation of organic and inorganic components of *Citrus sinensis* linn (musambi) and its effects on early growth of broiler chicks

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**Abstract**

**The utilization of the waste of *Citrus sinensis* (Musambi) was carried out in the form of poultry feed additive. The work was done in order to analyze the percentage of organic and inorganic components of *Citrus sinensis.* The dried samples of citrus waste were prepared from various dehydration techniques that included sun drying, oven drying and calcium oxide drying. The analysis was carried out for the various contents (i.e., moisture, mineral, fat, protein and fiber content). The same samples were then used in poultry feed so as to observe its effects on early growth of broiler chicks. In the component analysis no significant difference was observed in the percentages of moisture, fat, protein and fiber but in the mineral content of the samples treated with calcium oxide that was observed to be higher. In case of broiler chicks the growth effects were observed in three groups; i-e, A (control), B (5% citrus content), and C (10% citrus content). A slight decrease in the weight of the chicks was observed with an increase in the concentration of citrus content.**

**Key words:** *Citrus sinensis* (Musambi), broiler chicks

## INTRODUCTION

There is a wide range of by-products and residues obtained from food crops and food processing, which are potentially valuable feed supplement, and are called Solid Wastes**.** The economic success of any industry in general and the food industry in particular depends to an extent on the utilization of the waste products that are produced during the various stages of processing (Canteri et al., 2010). Fresh fruits and vegetables are very easily spoiled by the action of physical or biological factors, such as ageing, oxidation or microbial activity. During the preparation of fruits and vegetable products like juices, jams, dried products and canned products etc., a large quantity of waste materials are left over (Yapo and Koffi., 2008).

Citrus fruits are famous for its juices and aromatic oils. Its juices are rich source of vitamin c and oils serve as by-product of juice industry. The peelings, coverings, seeds, skin and trimmings can be used for producing by-products (Angulo et al., 2012). Over-ripe and defective materials are also used to get the by-products. Utilization of wastes in the production of valuable compounds helps minimize pollution (Bocco et al., 1998).

Rutacaea family contains 140 genera and 1300 species distributed throughout the world. Rutaceous plants are often aromatic by virtue of scented oils in leaves, flowers and fruits (Adsule and Kadam., 1995). Oils extracted from Citrus flowers are widely used in aromatherapy and as perfumes (Stone., 1973). The leaf

extract of a Cirus plant, *Clausena entate* is also reported to have potential in control of *Aedes aegypti* larvae, thus controlling dengue fever (Morton., 1987).

In the present study, work was being carried out on the *Citrus sinensis* (Musambi) and its waste utilization as broiler chick feed. The effect of citrus rind was observed on the growth of commercial stocks of chicken.

## MATERIALS AND METHODS

### A. Estimation of Organic and Inorganic Components

#### Estimation of Moisture Content

Organic and inorganic components of *Citrus sinensis* (Musambi) were estimated for their moisture content. After extracting the fruit juice, its waste was weighed before and after it was subjected to drying methods (i.e., Sun Drying, Oven Drying and Calcium Oxide Drying). The dried waste was homogenized by grinding.
Calculation: Percent Mass = (M1-M2/M1-M)*100, Where
M1 (g) = Mass of moisture dish with material before drying
M2 (g) = Mass of moisture dish with material after drying
M (g) = Mass of moisture dish when empty

#### Estimation of Mineral Content

For the estimation of mineral content, powdered waste was turned to ashes at 350˚C in a furnace for 6 hours. After ignition the weight of ash was proportional to the weight of the mineral content present in the sample (AOAC., 17$^{th}$ Ed & AOAC., 1990).
**Calculation:** Percent Ash = weight of ash * 100

#### **Estimation** of Fat Content

Soxhlet extraction was used to measure the fat content as described in AOAC. 01 gram of dried, ground and moisture free sample was taken in thimble pouch. 1.5 liters of hexane was taken in a round bottom flask and thimble pouches were put in middle part of the Soxhlet extractor. Hexane was heated at 40°C on heating plate for 16 hrs, during the whole period hexane, being a fat solvent was continuously volatilized, then condensed and allowed to pass through the thimble pouches to dissolve and take away the fat contents. The thimble pouches were put in the air to evaporate hexane completely and kept in oven for 24 hrs at 105°C (AOAC., 1999a)
Calculation: Percent Mass = (M1-M2/M) * 100, where
M1 (g) = Mass of Soxhlet Flask containing sample
M2 (g) = Mass of empty Soxhlet Flask
M (g) = Mass of sample taken

#### Estimation of Protein Content

For protein content estimation Kjeldahl method was performed as per AOAC description (Singh., 1990). After desiccation at 105°C, 2.0 gram of homogenize ground sample was transferred to digestion tube and added 7 gram of Potassium sulfate, 5 gram selenium powder, 12 ml concentrated sulfuric acid and 5 ml hydrogen peroxide. This mixture was boiled for 60 minutes on a hot plate at 400°C till a pale black solution was obtained. During this whole period the nitrogen was converted into ammonium sulfate. It was allowed to cool and the volume of the solution was raised up to 100 ml with distilled water. Nitrogen was estimated by Kjeldahl method. In this process 5 ml of digested sample was added in the Kjeldahl flask. To this 40% of sodium hydroxide was added in excess so as to convert ammonium sulfate into free ammonia. This ammonia gas was allowed to condense with the help of a condenser, and was collected in another flask. In this flask 10ml of 0.2% boric acid was added and the ammonia converted to ammonium borate. In the last step this ammonium borate was titrated with 0.2N HCl using methyl red as an indicator.
Calculation: Percent Crude Protein = Percent Nitrogen * F, Where
Percent Nitrogen =
[(VHCL*NHCL)–(VBK*NNaOH)–
(VNaOH*NNaOH)]/1.4007*W*Lab DM/100
Where
VHCL (ml) = Vol. of HCl taken for titration
NHCL = Normality of HCl
VBK (ml) = Vol. of NaOH required to titrate 1ml HCl – B
B = Vol. of NaOH required to titrate reagent Blank
VNaOH (ml) = Vol. of NaOH required to titrate sample
NNaOH = Normality of NaOH)]
1.4007 = miliequivalent weight of N*100
W (g) = Weight of sample
F = 6.25

#### Estimation of Fiber Content

Samples required for the estimation of fiber content were kept free from moisture and fat. Samples were in homogenized by grinding. 1.0 gram of fat and moisture free sample was taken in a 100ml round bottom flask and added 100ml of 1.25% concentrated $H_2SO_4$ and boiled the whole material at low flame for 30 minutes. Then the sample was filtered with Muslin cloth. To make the sample acid free consecutive washes were given with distilled water. After that the material was transferred via the filter cloth to the round bottom flask where 100ml of 1.25% NaOH solution was added and boiled again for 30 minutes at low flame. Foaming of the sample was avoided by adding antifoam. Sample was then filtered

**Table 1.** Composition of the various experimental feeds

| Ingredients | Ratios | | |
|---|---|---|---|
| | Feed. 1 (Control) | Feed. 2 (5%Citrus) | Feed. 3 (10%Citrus) |
| 1. Soya Bean Meal | 10% | 10% | 10% |
| 2. Maize Ground Powder | 30% | 30% | 30% |
| 3. Wheat Ground Powder | 28% | 28% | 28% |
| 4. Maize Gluten (60% Protein) | 2% | 2% | 2% |
| 5. Maize Gluten (30% Protein) | 3% | 3% | 3% |
| 6. Fish Meal | 4% | 4% | 4% |
| 7. Canola Meal | 8% | 8% | 8% |
| 8. Molasses (cane) | 3% | 3% | 3% |
| 9. Dicalcium Phosphate | 1% | 1% | 1% |
| 10. Vitamin Minerals | 1% | 1% | 1% |
| 11. Rice Polishing | **10%** | **5%** | **Nil** |
| 12. Citrus Content | **Nil** | **5%** | **10%** |

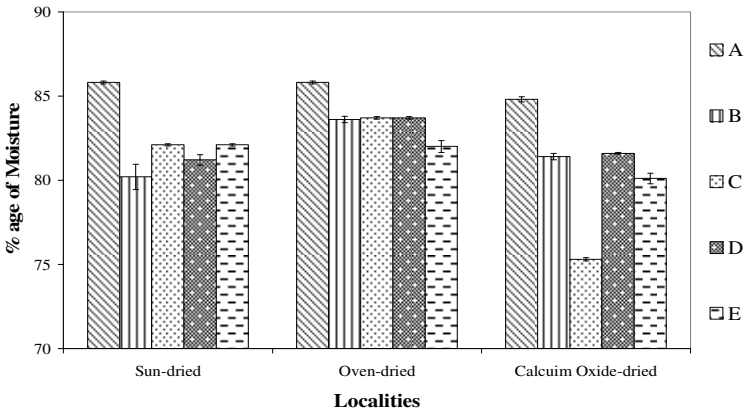


**Figure 1.** Percentage of Moisture Content in the various groups of *Citrus sinensis* (Musambi) for different drying methods

with a pre weight filter paper and made it alkali free with distilled water washes. The sample along with the filter paper was put in oven at 100°C over night. After taking the sample out of the oven it was placed in crucible already weighed that was then put in furnace over night. After the completion of ignition the crucible was taken out and weighed again. The difference between the weight of the crucible before and after was actually the weight of fiber (Banergy., 1988).

Percent Mass = (M1-M2/M) * 100 where

M1 (g) = Mass of crucible containing sample

M2 (g) = Mass of empty crucible

M (g) = Mass of sample taken

### B. Citrus Rind as Poultry Feed Additive

Citrus was used as food additive in poultry feed. *Citrus sinensis* (Musambi) was collected from different localities of Lahore and their powder was used as food additive of poultry. Three feeds with different levels of citrus powder were prepared and chicks were fed on these three types of feed (Table 1). This research was conducted for 4 weeks. There were maintained three groups of poultry, each with 40 members. The groups were termed as: Group 1 (control), Group 2 (5% citrus content) and Group 3 (10% citrus content). Group 2 and Group 3 were the experimental groups. This research was concerned with

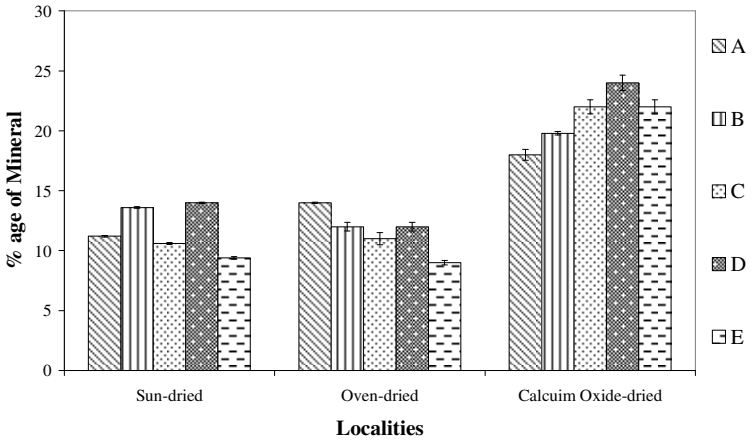


**Figure 2.** Percentage of Mineral Content in the various groups of *Citrus sinensis* (Musambi) for different drying methods

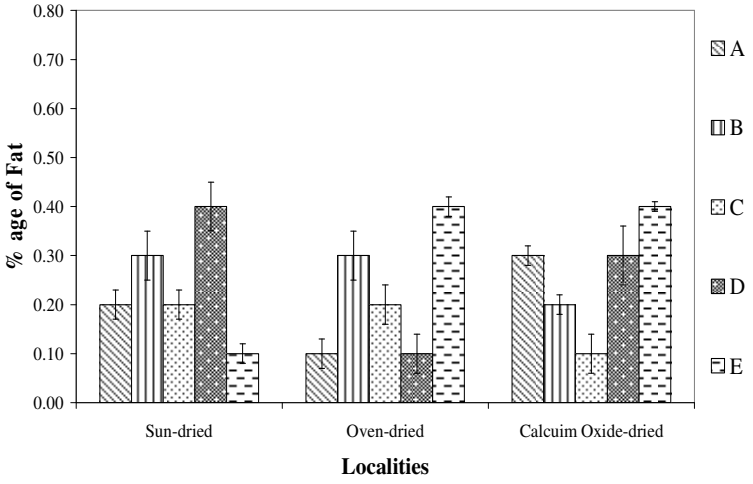


**Figure 3.** Percentage of Fat Content in the various groups of *Citrus sinensis* (Musambi) for different drying methods

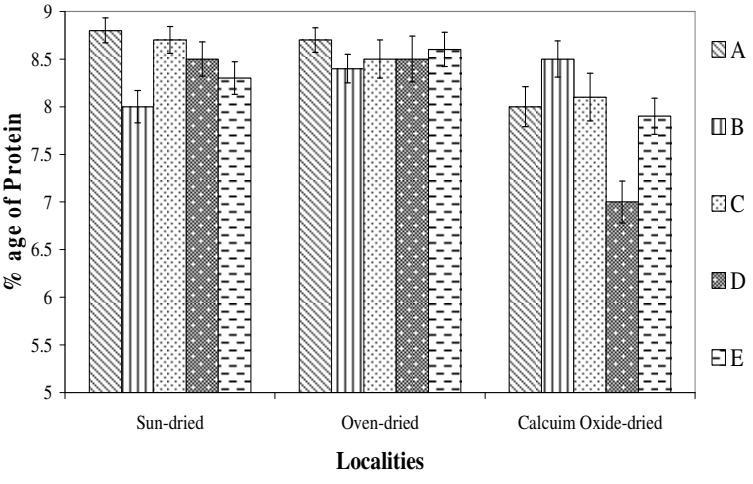


**Figure 4.** Percentage of Protein Content in the various groups of *Citrus sinensis* (Musambi) for different drying methods

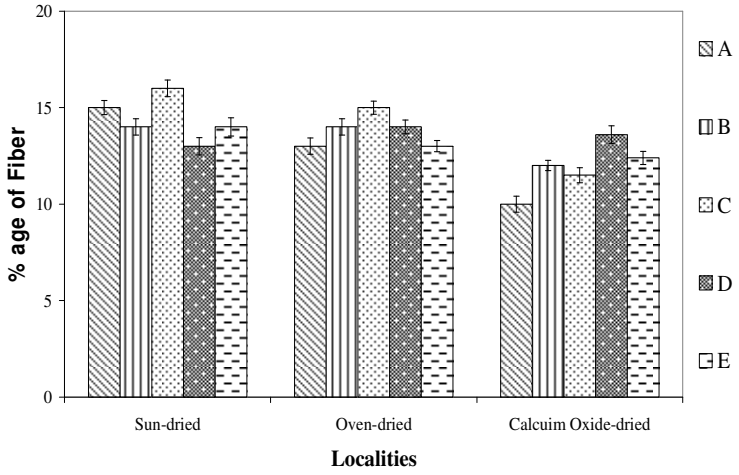


**Figure 5.** Percentage of Fiber Content in the various groups of *Citrus sinensis* (Musambi) for different drying methods

**Table 2.** Growth performance of chicks fed on different diets

| Week | Group | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| | Mean ± S.E | Mean ± S.E | Mean ± S.E |
| **0** | 35±0.4 | 35±0.5 | 35±0.5 |
| **1** | 190±0.9 | 190±1.3 | 190±1.4 |
| **2** | 360±1.6 | 350±2.5 | 358±2.1 |
| **3** | 726±2.2 | 708±2.4 | 712±2.8 |
| **4** | 1080±3.7 | 1020±3.5 | 990±1.1 |

the comparison of growth factor among the three groups. Chicks were weighed initially and then after every week for about 4 weeks and their results were compared. Different parameters were determined during the experimental studies (Figure 1 to 5). Finally, chicks were weighed at the end of the 4th week and were then subjected to t-test and significance was determined.

## RESULTS

The difference in the various nutritional components being dried via the above mentioned techniques was observed to be negligible for most of the components other than the mineral content (Shown in graphs 1-5). The reason after that was definitely the use of Calcium Oxide as the third drying method. The use of dried waste as poultry feed gave some clear results (Table 2). With an increase in the percentage of citrus waste in the poultry feed a slight fall in weight was observed and vice versa. The Musambi fruits were purchased from five different localities of Lahore city and were subjected to various dehydration techniques (1. Sun drying, 2. Oven drying and 3. Calcium Oxide drying) afterwards the nutritive analysis was carried out.

### A. Nutritional Evaluation

### Estimation of Moisture Content

Locality A- Barkat Market: moisture content of three groups was as follows: Group $A_1$ 85.8±0.08, Group $A_2$ 85.8±0.08, Group $A_3$ 84.8±0.15.

Locality B-Anarkali Bazar: moisture content was as in Group $B_1$ 80.2±0.75, Group $B_2$ 83.6±0.19 and Group $B_3$ 81.5±0.20.

Locality C-Fruit Mandi: moisture content of Group $C_1$ 82.1±0.07, Group $C_2$ 83.7±0.07 and Group $C_3$ 75.3±0.09.

Locality D-Fruit Market Railway Workshop: moisture content of Group $D_1$ 81.2±0.32, Group $D_2$ 83.7± 0.07and Group $D_3$ 81.6±0.05.

Locality E-Moon Market: moisture content of Group $E_1$ 82.1±0.07, Group $E_2$ 82.0±0.35 and Group $E_3$ 80.1±0.31.

### Estimation of Mineral Content

Locality A- Barkat Market mineral: content of three groups was as follows: Group $A_1$ 11.2±0.06, Group $A_2$ 14.0±0.06 and Group $A_3$ 18.0±0.45.

Locality B- Anarkali Bazar: mineral content was as in

Group $B_1$13.6±0.07, Group $B_2$ 12.0±0.36 and Group B3 19.8±0.14.
Locality C-Fruit Mandi: mineral content of Group $C_1$ 10.6±0.07, Group $C_2$ 11.0±0.50and Group $C_3$ 22.0±0.59.
Locality D-Fruit Market Railway Workshop: mineral content of Group $D_1$ 14.0±0.06, Group $D_2$ 12.0±0.36 and Group $D_3$ 24.0±0.63.
Locality E-Moon Market: mineral content of Group $E_1$ 9.4±0.11, Group $E_2$ 9.0±0.19and Group $E_3$ 22.0±0.59.

**Estimation of Fat Content**

Locality A- Barkat Market: fat content of three groups was as follows: Group $A_1$ 0.2±0.03, Group $A_2$ 0.1±0.03 and Group $A_3$ 0.3±0.02.
Locality B-Anarkali Bazar: fat content was as in Group $B_1$ 0.3±0.05, Group $B_2$ 0.3±0.05 and Group $B_3$ 0.2±0.02.
Locality C-Fruit Mandi: estimated fat content of Group $C_1$ 0.2±0.03, Group $C_2$ 0.2±0.04 and Group $C_3$ 0.1±0.04.
Locality D-Fruit Market Railway Workshop: fat content of Group $D_1$ 0.4±0.05, Group $D_2$ 0.1±0.04and Group $D_1$ 0.3±0.06.
Locality E-Moon Market: fat content of Group $E_1$ 0.1±0.02, Group $E_2$ 0.4±0.02 and Group $E_3$0.4±0.01.

**Estimation of Protein Content**

Locality A- Barkat Market: protein content of three groups was as follows: Group $A_1$ 8.8±0.13, Group $A_2$ 8.7±0.13 and Group $A_3$ 8.0±0.21.
Locality B-Anarkali Bazar: protein content was as in Group $B_1$ 8.0±0.17, Group $B_2$ 8.4±0.15 and Group $B_1$8.5±0.19.
Locality C-Fruit Mandi: protein content of Group $C_1$ 8.7±0.14, Group $C_2$ 8.5±0.20and Group $C_3$8.0±0.25.
Locality D-Fruit Market Railway Workshop: protein content of Group $D_1$ 8.5±0.18, Group $D_2$ 8.5±0.24and Group $D_3$ 7.0±0.22.
Locality E-Moon Market: protein content of Group $E_1$ 8.3±0.17, Group $E_2$ 8.6±0.18 and Group $E_3$ 7.9±0.19.

**Estimation of Fiber Content**

Locality A- Barkat Market: fiber content of three groups was as follows: Group $A_1$ 15.0±0.36, Group $A_2$ 13.0±0.42 and Group $A_3$ 10.0±0.42.
Locality B-Anarkali Bazar: fiber content was as in Group $B_1$ 14.0±0.43, Group $B_2$ 14.0±0.42 and Group $B_3$ 12.0±0.27.
Locality C-Fruit Mandi: fiber content of Group $C_1$ 16.0±0.43, Group $C_2$ 15.0±0.34 and Group $C_3$ 11.5±0.39.
Locality D-Fruit Market Railway Workshop: fiber content of Group $D_1$ 13.0±0.45, Group $D_2$ 14.0±0.35 and Group $D_3$ 13.6±0.46.
Locality E-Moon Market: fiber content of Group $E_1$ 14.0±0.47, Group $E_2$ 13.0±0.29 and Group $E_3$ 12.4±0.34.

**B. Growth Performance of Chicks**

**Initial Weight of CHICKS**

The initial weight of the initial weight of the experimental chicks was observed to make a comparison between their weight gain and loss in the next experimental weeks. The initial weight of chicks was observed to be the same for all the three groups. The initial weight of chicks was 35 grams.

**Weekly Weight of Chicks**

The experiment was set for four weeks and the weekly weight of chicks was observed so as to determine the effect of citrus feed additive. In the 1st week, the chicks of each group were weighed and their body weight difference was observed. Chicks of Group 1 (control) had a mean weight of 190±1.3, Group 2 (5% citrus content) were of 190±1.5 and for Group 3 (10% citrus content) it was 190±1.9. The mean difference was insignificant at the 0.05 level ($P \geq 0.05$). In the 2nd week, chicks of Group 1 (control) weight around 360±1.6, Group 2 (5% citrus content) weighed at 350±2.5 and those of Group 3 weighed at 358±2.1. The mean difference was insignificant at the 0.05 level ($P \geq 0.05$). In the 3rd week, the chicks were weighed again and in Group 1 (control) weight of chicks was around 726±2.5, Group 2 (5% citrus content) weight was 708±2.8 and as for Group 3 (10% citrus content) it was 712±2.8. The mean difference was significant at the 0.05 level ($P \leq 0.05$).

**Final Weight**

Fourth week was the last experimental week thus the weight recorded in this week was said to be the final weight. Group 1 (control) had a final weight value of 1080±3.7, Group 2 (5% citrus content) had final weight of 1020±3.5 and for Group 3 (10% citrus content) it was 990±1.1. The mean difference was significant at the 0.05 level ($P \leq 0.05$).

**DISCUSSION**

Oranges are primarily eaten out-of-hand or as orange juice, or the sections are used in fruit salads (Spiegel.,

1996). The genus citrus has a wide variety of fruits among which some are sweet while others are sour. The present study was concerned with the sweet orange, *Citrus sinensis* (Musambi). Musambi is a hybrid of two original breeds and tastes sweet. A major contribution is thus made in the production of solid wastes. This waste must be treated properly and discarded or it may result in severe environmental stresses (Castle., 1987).

The present study was concerned with the utilization of citrus rind as animal feed additive. The major problem in such an application is usually due to the heavy moisture content, which decomposes all the material, making a huge environmental disaster and also of economy, so an experimental setup was created to find such a dehydration method that will be cheaper than others (Dugo., 2002).

The citrus rind was subjected to three different dehydration methods that included sources of Sun, Oven and Calcium Oxide. It was then estimated that which one of the three will be the cheapest way of drying the citrus rind and providing a nutritionally better but cheaper feed to animals e.g. poultry, cattle etc. an economic survey was then held in order to estimate the economically more beneficial methodology (AOAC., 17$^{th}$ Ed).

## CONCLUSION

In the present study it was observed that the drying technique left no noticeable inpact on the composition of the citrus rind except for an increase in mineral content as expected. The use of citrus rind as an additive in chick feed had a negative result on the early growth of chicks and resulted in a drop of weight. Thus, it is concluded that the citrus rind is not much suitable a feed additive in chick diet as it was expected as per the reported results in cattle.

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