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Preface

We would like to present, with great pleasure, the inaugural volume-9, Issue-3, March 2023, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

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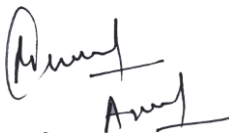
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.



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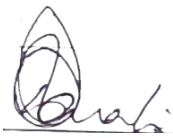

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Growth Performance and Haematological Characteristics of Growing Rabbits Fed Concentrates and Forage

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Abstract— *This study evaluated the haematology and growth performance of growing rabbits fed concentrate diet and forage (Panicum maximum and Gynura aurantiaca). Twenty-four (24) growing rabbits at eight weeks (8) of age comprising of both sexes were randomly assigned to four (4) treatment groups of six (6) animals each and three (3) replicates per treatment with two (2) rabbits per replicate. The rabbits were balanced on initial weight basis. The treatment groups include T1, T2, T3 and T4. T1 (control) had 100 concentrate diet, T2 had 50%:50% of concentrate and Panicum maximum, T3 had 50%:50% of concentrate and Gynura aurantiaca and T4 had 50%:25%:25% of concentrate+Panicum maximum+Gynura aurantiaca respectively. The study was arranged in a Completely Randomized Design (CRD) format. The experiment lasted for eight (8) weeks. Pack cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), White Blood Cell (WBC), Neutrophil (N), Plateletes (PLT), Lymphocytes (L), Eosinophil (E) and Monocyte values ranged from 29.50 – 42.47%, 9.85 – 14.20%, 4.5 – 6.30%, 5.00 – 8.75%, 23.50 – 41.50%%, 206.00 – 268.50%, 49.00 – 68.52%, 2.50 – 4.00% and 4.00 – 7.50% respectively. Final weight, Weight gain, feed intake and FCR ranged from 1316 - 2108.33, 483.33 – 1008.33, 2554.63 – 3148.50 and 30.19 – 64.13 respectively. Panicum maximum and Gynura aurantiaca inclusion at different levels had a significant (P≥0.05) effect on haematological characteristics and growth performance of growing rabbits. Forages could be fed at 50%:50 %ratio of concentrate and forage in the diets of growing rabbits. Forages and concentrates is recommended at 50%:50% ratio is the diets of growing rabbits.*

Keywords— Rabbits, Gynura aurantiaca, Panicum maximum, Performance and Haematology.

I. INTRODUCTION

Food security is a widely debated development issue and yet remains a global challenge, as food insecurity becomes acute especially among vulnerable groups (marginal population, dependent population and victims of conflict) of the world (1; 2). Nigeria like many other developing countries of the world has a protein deficiency gap, especially that of quality animal protein (3). (4), also stated that reduction in the availability of animal protein due to poverty, overall economic slump, and low production of indigenous breeds of animals are some of the reasons for this insufficient intake of animal proteins. This low protein intake has remained a major nutritional problem, especially for the low income and non- wage earners (5). Proteins are among the most important nutrients in human diets, and an adequate protein supply is a prerequisite for normal growth and development of all organs in the body (6).

Inadequate supply of protein from the traditional livestock- cattle, sheep goat and chickens has led to the intensification of efforts to improve on productivity of these animals and to maximize food production and meet protein requirements in Nigeria, viable options need to be explored and evaluated (6). Studies show that the most viable option to bridge the protein malnutrition between the resource-poor world people and the resource-rich citizens is the utilization of short gestation unconventional livestock, especially monogastric animals (Rabbits and Pigs), of which rabbit is the most favoured (7). Hence, rabbits have been thought of as being suitable in this regard.

The preference of rabbit to other animals could be allied to intrinsic qualities of the animal which include: short gestation period, ease of management and, its highly prolific ability. Its practice of caecotrophy enhances its performance, relatively low

cost of production compared to other monogastric animals, high rate of reproduction, early maturity, small body size, rapid growth rate comparable to that of broiler chicken (8; 9), high genetic selection potential, efficient feed and land space utilization. Other qualities include ability to thrive on green forage, food wastes and agricultural by-products, potential income generation and limited competition with humans for similar food (9).

Rabbit meat has high nutritional value with high protein (56%), low fat (9%), low in cholesterol, sodium and calories (8%) and contain 28% phosphorus, 13% iron, 16% zinc, 14% riboflavin, 6% thiamine, 35% B12 and 48% niacin – making it ideal meat for hypertensive patients. Also, rabbitry requires comparatively low level of capital set – up, requiring little space and it is well-adapted to domestic rearing (7). Rabbits are maintained primarily on forages or concentrates alone, optimal productivity cannot be achieved (10).

Some of the conventional forages used for feeding rabbits include *Panicum maximum, Pureraria phaseloides, Centrosema pubescens, Mucuna cochinchinensis* and *Sida acuta* (11). Increased feed and nutrient levels have been advocated for breeding rabbits as a means of increasing litter size, adequate pregnancy maintenance and milk production by the does (12). However, the farmers are generally confronted with problems of high cost of concentrates, relatively smaller weight gain during the dry season, non-readily available market when the farmers are ready to sell their stock and inadequate knowledge and information about the advantages of eating rabbit meat (9). But to enhance rabbit production and productivity requires that resources are efficiently used with attention paid on profit maximization at minimum cost (13) and profit efficiency will lead to greater benefits to livestock producers in the country (14), (15) and (16) reported that *Panicum maximum* has dry matter (DM) content of 68.43-77.64 , CP ranged of 13.78, crude fibre 18.50 , NFE of 41.10 , ether extract of 6.00 and ash content of 19.80. Also works of (17) reported that the nutritive composition of *Gynura aurantiaca* contains 2.1 % crude protein, 0.6% crude fat, 1.4% ash, and 4.8% carbohydrate. They also buttressed that *Gynura aurantiaca* has an average nutrient concentration (in g/100 g of DM) of 2.08 for potassium (K), 0.31 for phosphorus (P), 0.61 for magnesium (Mg) and 6.59 for manganese (Mn). This suggests that *Panicum maximum* and *Gynura aurantiaca* could be harnessed efficiently in ruminant feeding.

II. MATERIALS AND METHODS

2.1 Location/Duration

The experiment was conducted at the Rabbitry unit, University of Port Harcourt Research and Demonstration Farm, Choba, Rivers state, Nigeria. The farm is 2 km to the University of Port Harcourt, Choba, Rivers State with annual temperature of 28°C. The experiment was conducted for a period of eight (8) weeks.

2.2 Experimental Animal and Design

Twenty-four (24) rabbits at eight (8) weeks of age comprising of both sexes with average weight of 435-438g were obtained from the rabbitry unit of Ignatius Ajuru University of Education Research and Teaching Farm, Rivers State, Nigeria.

The rabbits were randomly allotted to four treatments in a completely randomized design (CRD) with six (6) rabbits per treatment and two (2) rabbits per replicate. The rabbits were distributed randomly into four dietary treatment groups (T1, T2, T3, and T4).

The treatment diets were formulated as follows;

T1 : 100% concentrate (Control)

T2 : 50% concentrate + 50% *panicum maximum* (C+G)

T3 : 50% concentrate + 50% purple velvet (C+L)

T4 : 50% concentrate + 25% *panicum maximum* + 25% purple velvet (C+G+L).

2.3 Source of Experimental Feed Ingredient

The concentrate ingredients were obtained from Modern Agro Enterprise Port Harcourt, Rivers state while the *Panicum maximum* and *Gynura aurantiaca* were obtained from Aluu community. Thus, the forages were sundried for 2-3 days, ground, and incorporated with the concentrate before being fed to the rabbits.

TABLE 1
CALCULATED INGREDIENT OF CONCENTRATE FEED

Ingredients	T1
PKC	5.00
Maize	45.00
Maize offal	7.00
Wheat bran	4.50
Soya bean meal	16.00
Groundnut cake	11.00
Fish	4.75
Bone meal	3.00
Salt	0.25
Methionine	0.50
Lysine	0.50
Vitamin/ mineral premix	2.50
Total	100

TABLE 2
PROXIMATE COMPOSITION OF EXPERIMENTAL DIET

Feed ingredients (%)	T1
Dry matter	85.60
Crude protein	15.34
Crude fat	9.93
Ash	4.43
Crude fibre	15.27
Nitrogen free extract	41.55

TABLE 3
PROXIMATE COMPOSITION OF *PANICUM MAXIMUM*

Nutrient	Composition (%)
Dry matter	94.64
Crude protein	5.69
Crude fat	9.5
Ash	6.06
Ash	6.6
Crude Fibre	19.2
Nitrogen free extract	**53.62**

TABLE 4
PROXIMATE COMPOSITION OF *GYNURA AURANTIACA*

Nutrient	Composition (%)
Dry matter	97.95
Crude protein	5.69
Crude fat	3.40
Ash	5.80
Ash	5.80
Crude Fibre	57.01
Nitrogen free extract	**26.05**

2.4 Experimental Housing and Management

Panicum maximum and *Gynura aurantiaca* were fed to the rabbits after one week from arrival. The rabbits were allowed to acclimatize to the new environment for a period of seven days, after which, live weight differences between treatment groups were obtained. During the experiment, routine management was followed, and sanitary conditions were adequately maintained. Throughout the experiment, all treatment groups were given unlimited access to food and water (*ad libitum*). The rabbit was raised in hutches of 50cm by 35cm by 40cm dimensions. Intensive practice was adopted for this treatment.

2.5 Data Collection and Analysis

2.5.1 Weight Gain

The initial body weight of the rabbits were measured on arrival. The animals were weighed on weekly basis to determine weekly weight gain. At the end of the experiment, the rabbits were weighed and final weight was measured by subtracting the initial weight from the final weight. Body weight changes were determined by difference. An automatic weighing scale was used in determining the weight changes of rabbits.

Weight gain = final weight – initial weight

2.5.2 Feed Intake

The rabbits received weighed portions of feed daily between 7:00 and 8:00 in the morning, with the amount of feed being adjusted weekly to account for changes in weight. Water was given to the rabbits without restriction. Every day, leftover feed were collected and weighed on a scale. By deducting the leftover feed from the initial feed given, the daily feed intake was calculated.

Feed intake = Initial feed given —Leftover feed

2.5.3 Feed Conversion Ratio (FCR)

Feed conversion ratio represents the proportion of food that is converted into meat. It is calculated as feed intake divided by weight gain per rabbit throughout the study period.

$$\text{Feed conversion ratio} = \frac{\text{feed intake}}{\text{weight gain}}$$

2.5.4 Mortality

Mortality rate was evaluated by recording the number of deaths that occurred among the rabbits during the experimental period and it was expressed as percentage of the rabbit stock.

2.5.5 Haematological Parameters

At the end of the experiment, set of blood samples were collected from three rabbits per treatment using 3ml disposable syringe and was transferred into EDTA (Ethylene diameter tetra-acetic acid) bottles for haematological analysis such as; Packed Cell Volume (PCV), Haemoglobin (HB), Red Blood Cell (RBC), White Blood Cell (WBC), Platelets, Eosinophils, Neutrophils, Monocytes, Lymphocytes, Mean Corpuscular Volume (MCV) And Mean Hemoglobin Concentration (MHC) and Mean Corpuscular Hemoglobin Concentration (MCHC) (18).

Packed cell volume (PCV) was determined with Wintrobe's microhaematocrit method while Red blood cell (RBC) and White blood cell (WBC) was determined with improved Neubauer haemocytometer. The haemoglobin concentration (Hb) was determined using cyano-methaemoglobin method. The erythrocytic indices, mean cell volume (MCV), mean cell haemoglobin (MCH), and mean cell haemoglobin concentration (MCHC) was computed as described by (19).

2.6 Statistical Analysis

All data obtained were subjected to the Analysis of Variance (ANOVA). Significant treatments means were separated using Least Significance Difference (LSD) using the Statistical Package for Social Sciences (SPSS) software. Results were presents in tables.

2.6.1 Statistical model

The Statistical Model is stated as;

$$Yij = U + Ti + Eij$$

Where; Yij = Single Observation

U = Population mean

Ti = Effect where i^{th} treatment where i = 1, 2…4

Eij = Random error.

III. RESULTS

3.1 Effect of *Panicum maximum* and *Gynura aurantiaca* on Growth Parameters of Rabbit

Table 4.0 shows the effect of *panicum maximum* and *gynura aurantiaca* on growth parameters of rabbit. Initial weight, final weight, weight gain, feed intake and Feed conversion Ratio (FCR) showed significant difference ($P \leq 0.05$) within all treatment groups. In final weight, T4 was significantly ($P \leq 0.05$) different from T1, T2 and T3. T4 (2108.33) had the highest value, followed by T3 (1483.33) and T1 (1341.66) with T2 (1316.67) being the least value. Feed intake showed significant difference ($P \leq 0.05$). T4 (3148.50) had the highest value, followed by T2 (2820.00) then T3 (2583.00) and T1 (2554.63) having the least value although T2, T3 and T4 showed no significant ($P \geq 0.05$) difference, there was slight increase in their numerical values. The Feed Conversion Ratio (FCR) value was highest in T4 (64.13), followed by T2 (50.196) then T1 (37.14) and T3 (30.19) having the least value. T1 and T3 were not significantly ($P \geq 0.05$) different.

TABLE 5
GROWTH PARAMETERS OF RABBITS FED PANICUM MAXIMUM AND *GYNURA AURANTIACA*

Parameters	T_1	T_2	T_3	T_4
Initial weight (g)	750.00±232.14	833.33±232.14	833.33±232.14	1100.00±232.14
Final weight (g)	1341.66 ± 169.0^{b}	1316.67 ± 169.04^{b}	1483.33 ± 169.04^{b}	2108.33 ± 169.04^{a}
weight gain (g)	591.66 ± 286.04^{b}	483.33 ± 286.04^{c}	650.00 ± 286.04^{ab}	1008.33 ± 286.04^{a}
Feed intake (g)	2554.63 ± 189.5^{b}	2820.00 ± 189.53^{ab}	2583.00 ± 189.53^{b}	3148.50 ± 189.53^{a}
Feed conversion ratio (g)	37.14 ± 26.10^{c}	50.19 ± 26.10^{b}	30.19 ± 26.10^{c}	64.13 ± 26.10^{a}

[ab] Means within a row with different superscripts differ significantly at (P<0.05)

3.2 Effect of panicum maximum and *gynura aurantiaca* on Haematological Values of Growing Rabbits

Table 5 shows the effect of concentrate and forage on haematological parameters of rabbits. The result revealed that Pack Cell Volume, Haemoglobin, Red Blood Cell, White Blood Cell, Neutrophil, Platelet, Lymphocyte and Monocytes was significantly affected ($P \leq 0.05$) along different treatment groups.

1. **Pack cell volume:** Treatment 3 (42.47) had the highest response ($P \leq 0.05$) on PVC values while treatment 2 (29.50) had the lowest response ($P \leq 0.05$) on PVC values, however treatments 1 (37.50) and treatment 4 (35.50) showed no significant difference in their values.
2. **Haemoglobin:** The result on HB values showed that treatment 3 (14.20) and treatment 1 (12.50) was significantly ($P \leq 0.05$) higher than treatment 4 (10.20) and treatment 2 (9.85). Treatment 3 (14.20) showed the highest value and treatment

2 (9.85) with the least value. The treatment effect also showed that treatment 4 (10.20) and treatment 2 (9.85) had no significant difference between their values.

3. **Red blood cell:** Treatment 3 (6.30) had the highest response ($P \leq 0.05$) on RBC values while treatment 2 (4.55), and 4 (4.5) respectively had the least value with no significant difference. Treatment 1 was the second highest with (5.65).
4. **White blood cell:** The result showed that treatment 4 (8.75) had the highest response ($P \leq 0.05$) of WBC and treatment 3 (5.00) had the least response. Treatment 2 (6.95) showed the second highest value and treatment 1 (6.65) showed the third highest value, however the two treatments (2 and 1) respectively showed no significance difference in their WBC values.
5. **Neutrophils:** The result on neutrophils showed that treatment 3 (23.50) had the least response, when compared to other treated groups.
6. **Platelets:** Platelet values in treatment 2 (268.50) showed a higher value than treatment 4 (262.50) but however showed no significant difference between its values. Treatment 1 (206.50) and 3 (206.00) showed a significant reduction in platelets values than treatment 2 (268.50) and 4 (262.50).
7. **Lymphocytes:** The treatment effect on lymphocyte values showed that treatment 3 (68.50) had the highest significant response ($P \leq 0.05$) while treatment 2 (49.00) showed the least response ($P \leq 0.05$) on lymphocyte values. Treatment 1, 2 and 4 also showed a significant reduction in their lymphocyte values with no significant difference between their values.
8. **Eosinophil:** Eosinophil value showed no significant ($P \geq 0.05$) influence amongst the groups but treatment 2 (3.00) and 3 (3.00) had the same numerical values of eosinophil and all the treatment showed a slight increase in numerical values.
9. **Monocyte:** The results showed that treatment 1 (7.50) had the highest significant response ($P \leq 0.05$) while treatment 4 had the least significant response ($P \leq 0.05$) on monocyte values.

IV. DISCUSSIONS

4.1 Growth Performance

The highest values of weight gain among rabbits in T3 could mean that an equal mixture of concentrate and purple velvet plant gave better weight gain than concentrate mixed with *panicum maximum* (T2). This result is in agreement with the report of (20) which said that highest weight gain was recorded in rabbits on treatment 3 (50C: 50F) concentrate and forage ratio. The superior value of T2 could be attributed to the high palatability of *panicum maximum* diet compared to purple velvet diet. The low value of feed intake in T1 can also be attributed to the absence of forage in the diet. The highest feed intake value of T4 could be attributed to an equal combination of the two test plants along with concentrate. Thus, the best Feed Conversion Ratio (FCR) in T3 (30.19), could be attributed to the absence of forage in the diet. T4 (64.13) had the highest value and this can be attributed to higher percentage of forage (mixture of *Panicum maximum* and purple velvet) and poor nutrient retention by the animals in T4. This was in tandem with those reported by (20) who recorded similar result on feed conversion ratio of rabbits fed concentrate and forage. It also affirms that the mixture of treated diet could help in efficient conversion of the available nutrients into usable parts leading to the better performance in the study.

4.2 Haematological Parameters

The effect of feeding concentrates diet and forage (*panicum maximum* and *gynura aurantiaca*) to growing rabbits on haematological values – Pack Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), White blood Cell (WBC), Neutrophil (N), Platelets (P), Lymphocyte (L) and Monocyte (M) showed significant difference, except for Eosinophil (E) which did not show any significant difference. These results are in agreement with (21) who reported that there was significant difference in the haematological parameters of rabbits fed with graded levels of wild sunflower forage. This positive response proves that the test plants affect the haematological parameters of rabbits at various inclusion level. According to (22), the changes in haematological values are often used to determine various status of the animal's body and also determine the stress due to environmental, nutritional and pathological factors.

The PCV value of T2 (29.50), indicates possible anaemia, this is in agreement with (23) who reported that PCV less than 30% indicates anaemia, especially if the RBC and haemoglobin levels are low as well and this was evident in the result in **Table 6**. According to (24) increased PCV shows better transportation of nutrients, therefore feeding T3 diet would yield higher primary and secondary polycythemia than T2, T1 and T4 diet.

The significant increase in the value of RBC in T3 can be attributed to the high value of PCV in the same treatment. High RBC could be a result of increasing freedom from disease, this was reported by (25). (26) also suggested that increase in RBC, counts as an indication of reduced damage to erythrocytes.

The higher values obtained for Haemoglobin concentration (Hb) in T3 (14.20), and T1 (12.50) compared to T4 (10.20) and T2 (9.85), which fell within the normal range (10 - 15) for rabbits as reported by (27), could be due to increased biosynthesis of haem in bone marrow (28). The same goes for the similarity in PCV values of T3 (42.47) and T1 (37.50), since haemoglobin has direct relationship with PCV.

The values of WBC also fell within the normal range of 4.5 – 11 (27), with T4 (8.75) being the highest, followed by T2 (6.95), T1 (6. 65) and T3 (5.00), being the least. Although T2 and T1 are not significantly different. The values of WBC compared favourably in the groups with very slight increase in numerical value. The significant effect of the treatments on WBC could mean that the test plants had stimulatory effect on the defense and immune system of the body (29)

Lymphocytes (L), Neutrophil (N), Eosinophil (E) and Monocyte (M) values fell within the normal range reported by (30). Eosinophils forms part of the granulocytes that make up leucocytes in animals. There was no significant difference in the eosinophil value and no observed abnormal linear decrease with equals levels of concentrate and the forages. This reflects the possible absence of toxin/ poison since there is nothing to promote inflammatory defense reaction from test plants. This corresponds with (31) who reported that the major function of eosinophil is detoxification.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From this study it was observed that for optimum performance of rabbit, they should be fed mixture of concentrate and Forage. Also, Inclusion of forage in the diet of rabbit is also needed to enhance feed intake. Furthermore, the combination of the test plants with concentrate seemed to yield adequate results in the haematological values of rabbits, therefore this combination can be utilized in rabbit production.

5.2 Recommendation

For optimum performance of rabbit, they should be fed 50% of concentrate and 50% of forage because this percentage gave highest average weight gain**.** From the result of the study, it may be adequate to combine more than one forage in rabbit diet.

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Effects of Feeding Noodle (Indomie) Waste on the Nutrient Digestibility and Cecal Parameters of Growing Rabbits

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Abstract— *In an 8-week feeding trial, the nutrient digestibility and cecal parameters of mixed breeds of rabbits fed with noodle waste in replacement of maize were evaluated. The rabbits were randomly assigned to four dietary treatments (T1, T2, T3, and T4) in a Completely Randomized Design (CRD). The indomie waste was incorporated in a conventional feed at an inclusion levels of 0%, 6%, 12%, and 18% respectively. At the end of the experiment, Nutrient digestibility and cecal parameters were assessed. The result from the study stipulated that the crude protein, dry matter, crude fat, ash, crude fibre and nitrogen free extract were significantly different (P < 0.05) among treatments. Increase in the inclusion levels of indomie waste led to increased digestibility in Dry matter, ash, and nitrogen free extract with rabbits in treatment 4 showing superior values in relative to other treatment groups. Also, rabbits fed diet 2 showed a significant increase in nutrient digestibility values (P < 0.05) in crude protein, crude fibre, and crude fat compared to those fed diets 1, 2 and 4 while crude fibre was better digested among rabbits in the control groups when compared to others. Furthermore, the cecal pH and NH_3 were significantly (P<0.05) influenced by the test diet with the highest value of cecal pH recorded among rabbits in Treatment 4 and decreased values of NH_3 when compared to other treatment groups. Rabbits fed 6% indomie waste shown better digestibility of nutrients when compared to other inclusion levels, this level of inclusion is therefore recommended to rabbit owner*.

Keywords— Cecal parameters, Indomie waste, Maize, Nutrient digestibility, Rabbit.

I. INTRODUCTION

The need for animal products will rise consistently in response to increasing world population which in turn is posing so much pressure on the livestock industry (Assan, 2018). To meet the growing demand for animal protein, mini livestock production has been identified as alternative animal production strategy that could bridge the gap. However, rabbit is the most common and accessible among other mini livestock class in Nigeria.

Increased rabbit production is a fast means of meeting the animal protein requirements of the Nigerian populace (Iyeghe-Erakpotobor *et al.,* 2002). This is because of its high fecundity, high genetic potential, rapid growth rate and relatively low cost of production. Rabbit (*Oryctolagus cuniculus*) has short generation interval, high prolificacy, good mothering ability and easy management requirements, with ability to utilize waste and other non-conventional feed sources. The unique digestive physiology of rabbit has made it possible to use what other single stomach animals cannot utilize. For instance, rabbits can feed on a wide variety of grasses, herbs, leafy weeds, vegetables and household wastes or garbage. Besides, rabbit meat is high in protein content (about 22 %), low in fat (about 4 %) and cholesterol (about 5 %) which can contribute positively towards improving the good health of the populace (Aduku and Olukosi, 1990).

Sadly, the increase in rabbit production in Nigeria is challenged with series of problems ranging from high cost of feed, poor nutrient digestibility, diseases, poor management system and host of others (Asar *et al*., 2010). Therefore, conscious efforts need to be made to address such menace with the view of keeping pace between supply and demand of quality animal protein from rabbits (Makinde *et al*., 2014).

II. MATERIALS AND METHODS

2.1 Experimental site and Duration

The experiment was conducted at the rabbitry unit of the Faculty of Agriculture Research and Demonstration Farm of the University of Port Harcourt, Choba Rivers State, Nigeria. It is located on the 4°45'N, 6°50'E,(4.750°N, 6.833°E),having an annual temperature of 26°C (78.8°F) (Chima and Ofodile, 2015).The experiment lasted for eight weeks (8)

2.2 Experimental Rabbits and Management

Twenty (24) dutch rabbits of both sex of about 8 weeks old with mean weight of 745 ± 2.5 g were used in this study. The rabbits were purchased from Micheal Okpara University of Agriculture, Animal Breeding unit, Umudike, Abia state. Prior to commencement of the experiment, the hutches were well cleaned and disinfected with saponated creso (Izal) and allowed to dry for seven (7) days before the rabbits were introduced therein. The rabbits were conditioned for seven days (7) to facilitate their adaptation of the rabbits to the new environment before commencement of the experiment. During the adaptation period, they were fed commercial ration (grower's mash) and water given ad-libitum. The rabbits were treated against external and internal parasites using *ivomectin* ® at 0.2ml per rabbit prior to commencement of the experiment. A broad spectrum antibiotic (water soluble powder) and protective, absorbent anti-diarrhoea (dry suspension) were used in drinking water against bacterial infection.

2.3 Experimental Design

24 Dutch rabbits were randomly assigned to four dietary treatments using a Completely Randomized Design (CRD), and were individually weighed having 6 rabbits each,

2.4 Experimental diet

The noodle waste for the feeding trail was purchased from Mordern Agro Enterprise, Port Harcourt, Rivers State. The noddle waste was formulated with conventional feed stated as follow, T1 contained 0% of noddle waste, T2 contained 6% of noddle waste, T3 contained 12% of noddle waste, and T4 contained 18% of noddle waste as shown in Table 1 below:

TABLE 1
PERCENTAGE INGREDIENTS AND CALCULATED NUTRIENT COMPOSITION OF THE DIETARY TREATMENTS

Ingredients	T1	T2	T3	T4
Yellow maize	48.00	42.09	36.09	30.09
Indomie waste	0.00	6.00	12.00	18.00
Wheat bran	10.75	10.75	10.75	10.75
PKC	12.42	12.42	12.42	12.42
Soybean Meal	12.0	12.0	12.0	12.0
GNC	8.48	8.48	8.48	8.48
Bone meal	4.5	4.5	4.5	4.5
Salt	0.13	0.13	0.13	0.13
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Vit/min premix	3.13	3.13	3.13	3.13
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**

TABLE 2
PROXIMATE COMPOSITION OF THE EXPERIMENTAL DIETS

Parameters	T_1	T_2	T_3	T_4	SEM
Crude protein	14.90^{d}	11.84^{c}	22.34^{b}	25.41^{a}	0.01
Dry matter	83.53^{d}	88.53^{a}	87.40^{c}	88.21^{b}	0.02
Crude fat	4.63^{a}	1.83^{c}	3.93^{b}	3.93^{b}	0.02
Ash	8.23^{a}	5.33^{b}	5.13^{c}	4.63^{d}	0.02
Crude fibre	7.10^{a}	2.14^{c}	7.00^{a}	4.65^{b}	0.02
NFE	48.68^{d}	67.41^{a}	54.02^{b}	49.61^{c}	0.07

^{a,b,}***Means within each rows showing different superscript differ significantly (P<0.05)***

2.5 Data Collection

2.5.1 Nutrient Digestibility

Digestibility study was conducted using four rabbits per treatment at the end of feeding trial. The faeces were weighed and oven-dried at 80^{o}C for twenty four hours (24 hrs). The oven-dried faeces per replicate were also weighed at the end of the digestibility study. The faeces from each replicate were bulked, thoroughly mixed together and ground. Samples of ground faeces were stored in airtight sample bottles for proximate analysis. The faecal samples was analyzed for dry matter (DM), crude protein (CP), crude fibre (CF) , ether extract (EE) and total ash (TA) at the Laboratory. Nitrogen-free extract (NFE) was also calculated as described by Association of Official Analytical Chemists (AOAC, 2006) as shown below:

%NFE = 100 – (%CP + %CF + %EE + %Ash)

Digestibility coefficients was calculated using the following equation:

Percentage digestibility = X100

2.5.2 Cecal parameters

Samples of cecal contents were collected from each rabbit (n = 16) into nylon bags after the animals were euthanized. Consistent with the procedures outlined by Belenguer *et al*. (2005), the cecal contents were immediately measured for pH with a glass electrode pH-meter. From these samples, two 1 g aliquots of cecal contents were acidified with 0.2 mol/L HCl and 0.15 mol/L H_3PO_4 into 50 mL disposable centrifuge vials and stored at −20 °C pending determination of ammonia and short chain fatty acids (SCFA), respectively. Samples for NH_3 analysis were mixed 1:1 with a 25% solution of meta-phosphoric acid and frozen, then separated into supernatant and analyzed according to the procedures of Mullins *et al*. (2007).

2.6 Statistical Analysis

Data collected from the study were analyzed with statistical analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS). Treatment means were compared using Duncan multiple range test of the same software.

The Statistical Model is stated as:

Yij = U + Ti + Eij

Where; Yij = Single Observation

U = Population mean

Ti = Effect where i^{th} treatment where i = 1, 2…4

Eij = Random error.

III. RESULTS

3.1 Nutrient digestibility of rabbit fed indomie waste as partial replacement for maize

The nutrient digestibility of rabbits fed indomie waste meal partially replaced for maize is presented in Table 3. The crude protein, dry matter, crude fat, ash, crude fibre and nitrogen free extract were significantly different (P < 0.05) among treatments. Increase in the inclusion levels of indomie waste led to increased digestibility in Dry matter, ash, and nitrogen free extract with

rabbits in Treatment 4 showing superior values with respect to other treated groups. Rabbits fed diet 2 showed a significant (P<0.05) increase in nutrient digestibility values in crude protein, crude fibre, and crude fat than those fed diets 1, 3, and 4. Thus, crude fibre was better digested among rabbits in the control groups when compared to others.

TABLE 3
NUTRIENT DIGESTIBILITY OF RABBIT FED INDOMIE WASTE AS PARTIAL REPLACEMENT FOR MAIZE

Parameters	T_1	T_2	T_3	T_4	SEM
Crude protein	72.33^b	112.70^a	27.19^d	30.76^c	0.77
Dry matter	25.52^b	24.79^c	17.71^d	28.02^a	0.04
Crude fat	12.43^d	223.55^a	194.01^b	53.35^c	8.6
Ash	35.59^c	86.86^b	88.24^b	261.15^a	4.23
Crude fibre	55.77^b	65.77^a	27.92^c	5.98^d	2.01
NFE	21.32^b	11.86^b	12.31^b	66.35^a	3.25

[a,b,]Means within each rows showing different superscript differ significantly (P<0.05)

3.2 Cecal parameters of rabbit fed indomie waste as partial replacement for maize

The cecal parameters of rabbit fed indomie waste as partial replacement for maize was shown in Table 4 Result from the study showed that cecal pH and NH_3 differs significantly (P<0.05) among the treated groups. Thus, values for cecal pH were statistically highest among rabbits fed Treatment 4 with decreased levels of NH_3 with respect to other dietary treatments.

TABLE 4
CECAL PARAMETERS OF RABBIT FED INDOMIE WASTE AS PARTIAL REPLACEMENT FOR MAIZE

Parameters	T1	T2	T3	T4	SEM
Cecal pH	6.45^b	6.41^b	6.33^c	7.01^a	0.02
Cecal NH_3	4.80^a	4.70^a	4.5^b	3.4^c	0.01

[a,b,] means within each rows showing different superscript differ significantly (P<0.05)

IV. DISCUSSION

The result from the present study was consistent with the works of Lala *et al*. (2011) who stated that the dry matter, crude protein, and crude fibre digestibility showed significant (P>0 05) difference with an inclusion of instant noddle waste in rabbits as compared to those in the control.Generally, dry matter content indicates the presence of and quantity of nutrients in a feed sample. Thus, the notable elevation in dry matter digestibility among rabbits fed diets 4 when compared to those in the control is in consonance with the findings of Ieuzo *et al*., (2013) and Fadiyimu *et al*. (2010) who recorded higher dry matter digestibility of growers rabbits fed corn based diet partially replaced with macaroni waste meal. This shows that indomie waste possess the nutrient requirements necessary for the wellbeing of the growers rabbits as corroborated by the works of Ortiz-Chura *et al*. (2018). The higher digestibility coefficient of crude protein obtained in diet 2 indicated that the dietary protein was better utilized by the rabbits fed the test diet. This perhaps supports the assertion that the inclusion of indomie waste meal partially replaced for maize may have influenced the digestibility, since dietary protein have been shown to enhance digestibility (Ahamefule, 2005). Similar results were also observed by (Cheek *et al*. (2014); Okolo *et al*. (2012) who reported that protein digestibility decreased with decreasing levels of dietary protein.

The results of crude fibre digestibility in this study showed that crude protein content of diets was positively correlated with crude fibre digestibility. Crude protein and crude fibre are components of dry matter and therefore any factor that affects the dry matter of a feed would similarly affect the crude protein and crude fibre component of the same feed (Ahamefule, 2005). This may explain why the digestibility coefficient of crude protein and crude fibre was elevated in T2. Furthermore, the higher crude fibre digestibility coefficient of T2 may suggest an increase in the activities of fibrolytic bacteria in the cecal content probably as a result of the availability of essential nutrients especially protein, energy, vitamins and minerals which are evident in indomie waste meal to enhance microbial growth and multiplication in grower rabbit.

With the exception of diet 1, the similarities in ash digestibility between the diets (T2, and T3) agrees with previous observations that diets with adequate mineral supplementation hardly vary in their total mineral digestibility Onifade and Tewe, (2013). Thus, the significant elevation in digestibility of fat in treatment 2 is in agreement with the observation of Cheek,

(2006) and Onifade and Tewe, (2013). This attested to the good ability of rabbits to utilize dietary fat in indomie waste meal partially replaced for maize as corroborated by the findings of Beyen, (2008).

However, the statistical similarities for nitrogen free extract in the control group, diet 2, and diet 3 during the study indicated that indomie waste possesses considerable extraction of energy to meet the energetic requirements of grower rabbits, and this is in line with the findings of Cheeke *et al*. (2011); Onifade and Tewe, (2013) that high values of digestibility in nitrogen free extract improves performance.

The significant ($P<0.05$) difference cecal PH observed in the present study are in accordance with those obtained by Taie *et al*. (2006) who found that incorporation of industrial waste in rabbit diets led to significant ($P<0.05$) differences in cecum parameters. This was contrary to the report by Helal *et al*. (2021) who stated absence of notable differences among rabbits fed graded levels of kitchen food waste and instant noddle waste. The noted confliction in the obtained results regard to the current result and those reported by the previous author may be related to breed of rabbit, method of determination, constituent of the feed and its utilization as supported by (Onifade and Tewe, (2013).However, (Abo-Egla *et al.* (2013) reported that caecum pH value is one of the most important factors which affect bacterial fermentation in the caecum. Thus, the significant increase of Caecum pH among rabbits fed 18% inclusion level of noddle waste was consistent with the works of Ramadan *et al*., (2009) who reported that the highest acidity was recorded for rabbits fed diets containing 16% crude fiber. So, such superior values of Caecum pH in the current study may be attributed to an increase in dietary fibre from the noddle waste due to increasing levels of the test diet from the study as opined by the works of (Bellier and Gidenne, (1996). This also shows that the high fibre content in noddle waste wasn't just indigestible, but fermentable carbohydrate which can escape degradation in the small intestine and reach the large intestine, to stimulate microbial growth and multiplication that could improve digestion of feeds (Dwivedi, 1991).

Concerning NH_3-N concentration, noddle waste supplementations influenced its activities with reference to control. According to Macfarlane and Gibson (1995) a series of factors could influence NH_3-N concentrations within the cecum, including H_2 pressure, chyme reaction, and carbohydrates availability. In comparison with ruminants, proteolytic activity in the rabbit cecum is relatively higher and ammonia levels fluctuate between 1.86–23.9 mmol·l-1 as shown by Gidenne, (1997) and Garcia *et al*. (2002). Thus, the reduced level of NH_3-N concentrations observed among rabbits fed partial replacement of maize with noddle waste at 18% inclusion levels could be attributed to the great ability of noddle waste to absorb ammonia. Ivan *et al* (1992) speculated that, industrial waste could also absorb some proportions of proteolytic enzymes, which would then be unable to act on the dietary proteins or it could absorb free dietary amino acids that also would not be accessible to bacterial fermentation. These results are in agreement with those reported in ruminants by (Saleh (1994) who found that, addition of industrial waste led to a decrease in ruminal NH_3-N concentration.

V. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Results from this study suggest that partial replacement of maize with noddle waste could lead to improvement in nutrient profiles of the rabbit diet and favorable modifications in cecal environment presumably, acidification of cecal contents and stabilization of ammonia nitrogen concentrations. These alterations should be considered as an advantage, as they improve the impact of the supplemented noddle waste on cecal fermentation pattern and rabbit metabolism.

5.2 Recommendation

Rabbits fed partially replaced noddle waste at 6% inclusion showed better digestibility of nutrients when compared to other inclusion levels and should be adopted by rabbitry owners, as well as nutritionist. However, subsequent investigations is recommended to complement the result from the present study.

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Impact of Covid-19 on Agricultural Output and Farm Inputs in Uttar Pradesh (India): An Empirical Analysis at Farm Household Level

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Abstract— *The present paper examines the impact of Covid-19 pandemic on agriculture sector of Uttar Pradesh and also assesses the impact of Covid-19 on farm/ crop production and availability of agricultural inputs. The primary information was collected from 360 farmers of 6 districts of Uttar Pradesh through structured farm household schedule. The macro level analysis shows that agricultural output has been found positive in Uttar Pradesh during the Covid-19 period. The farm household level results indicate that the agricultural output has declined as per 69.0 per cent respondents whereas it has increased for only 9.0 per cent farmers. As the output prices of the agricultural commodities are concerned, it has declined according to 62.0 per cent respondents. On the other hand 19.0 per cent reported an increase in the output prices of agricultural sector of farm household. The study also revealed that the availability of agricultural inputs declined and prices of farm input increased substantially. Moreover, it also found the performance of agriculture sector in Western Uttar Pradesh is better than the Bundelkhand region of the state. The present study suggests that agricultural infrastructural facilities, effective digitalization of agro activities and integrated agriculture cold chain need to be improved for mitigating the losses caused by such pandemic.*

Keywords— COVID-19, Agricultural Output, Farm Inputs and Uttar Pradesh.

JEL Classification: Q1, Q5 and O15.

I. INTRODUCTION

It has been extensively known that agriculture of Uttar Pradesh is one of the most operative tools for achieving higher growth and reducing poverty especially in rural areas (Kumar, Sanjeev et al., 2020). Agriculture sector is backbone of Uttar Pradesh economy, where around 50.0 per cent of the population depends directly on this sector for their livelihood. Moreover, agricultural sector occupies an important place in socio-economic space in the state with one-fourth of state domestic product and also providing the highest employment to the masses (UPDES, 2022). This sector is also a pivot point for food security of the country and plays a key role in supporting secondary and tertiary sector of the state. The fertile Indo-Gangetic plains play a vital role of agriculture sector in Uttar Pradesh. Agriculture sector of the state is a significant contributor to the national food security. Around 40.0 per cent of India's cereal (paddy & wheat crop) is produced by the state and the highest producer of cash crop i.e., sugarcane (Gulati et al., 2021).

In the year 2020, world experienced once in a century catastrophe which brought the economy to a standstill. Like calm before a storm, Covid-19 induced lockdown created a situation for an unforeseen chaos that affected lives and livelihood of billions across the world. For the first time in modern economic era both demand and supply got adversely hit. At its core, Covid-19 pandemic was a health crisis, but due to contagious nature of the disease governments all over the world reluctantly had to

impose lockdown to contain the spread which transformed a health crisis into a full fledge economic crisis. Furthermore it adversely affected all the sectors except agriculture. The Indian economy taking major hit during Covid-19 pandemic, agricultural sector showed most resilience towards harmful effects of the lockdown. Being the only sector with positive growth rate during Covid-19 pandemic it acted as a buffer to rural economy providing temporary employment to migrated laborers. Most of the states in India with higher share of agriculture in gross state value added (GSDP) witnessed a lower contraction in economic activity vis-à-vis states with higher share of industry and services (Goyal et.al. 2022)

The impact of pandemic on the agriculture sector differs from the other sectors of the economy, as well as region to region. The shortage of labor and machinery, limited access to crop fields and crop marketing, poor access to agricultural inputs, advisory services, supply chain disruptions and perishability of the products were reported as the major issues in the sector during this pandemic in India (Adhikari et.al., 2021; Kaur,2021)

II. LITERATURE REVIEW

Fox, Promkhambut and Yokying (2020) assess that how Covid-19 outbreak affects rice growing farmers of Southeast Asia. Rice growing farmers of Southeast Asia already having faced drought challenges suffered the havoc created by Covid-19 pandemic more or less at the same time. Having conducted telephonic interview of thirty farmers of Thailand in June 2020, it was reported that 65.0 per cent of farmers faced problems in the form of shortage of labour and unavailability of agriculture credit while purchasing agriculture inputs. They are unable to produce crops even for self-consumption. The paper shows the effects of Covid-19 pandemic on farmers i.e. rise in prices, unavailability of food and lack of government assistance. Although farmers of Thailand and Vietnam received basic government assistance but farmers of Cambodia, Myanmar and Laos are still struggling.

Umar and Abdin (2020) enquire into the changes in the consumption pattern of urban and rural India induced by the covid-19 pandemic. The study also evaluates the similarities and dissimilarities of the covid-19 induced changes in consumption pattern of rural and urban consumers. The study is based on primary data. The analysis reveals that the consumption pattern changed significantly during the pandemic period due to lockdown. It also reveals thatcovid-19 pandemic had a more profound effect on urban consumption as compared to rural consumption, due to the more diversified economy of urban space. Coming to the consumption basket, the pandemic caused a significant shift of consumption from non-essentials towards essential items.

Dilnashin, Birla, Rajput, Keswani, Singh, Minikina and Mandzhieva (2021) made an attempt to show post pandemic scenario in agriculture sector in the form of economic shock, by reviewing available online academic databases, Google Scholar, PubMed and Science Direct. Under the major sub-headings it discusses the impact of covid-19 pandemic on food security and rural livelihood, on agriculture supply chains, and trade relations. The pandemic completely triggered India's agriculture system. From the study it can be concluded that due to disruptions in supply chain, wholesale and retail prices of commodities increased significantly. Ultimately, if we fail to understand the impact of covid-19 on agriculture, we would be incompetent to deal with similar catastrophe in future. To overcome this kind of situation, policy makers need to revaluate the agricultural policies and structure in India.

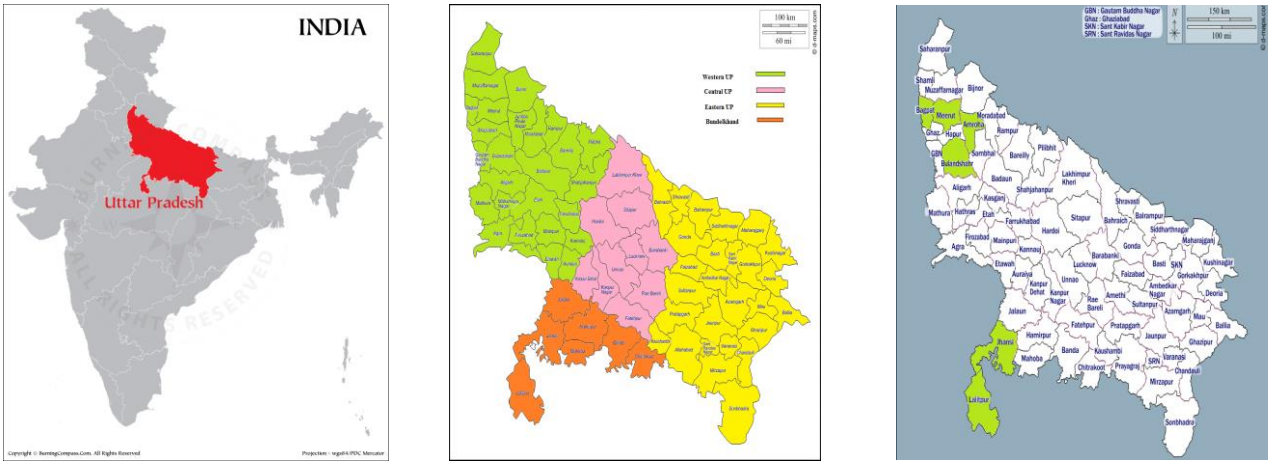
Mohanty and Jaimon (2021) focused on 6 major states of India to study the economic consequences of Covid-19 induced lockdown on consumption, labour and income, healthcare, access to relief programs and migration. The study concludes that the first wave had tremendous socio-economic impact on rural households that was aggravated by second wave. The study also highlights that there is lack of full understanding of the damage done by lockdown hence suggested further studies to be undertaken by the government to estimate the loss of rural economy.

Goyal, Kovuri and Golait (2022) is a presence across nation (PAN) India study of asymmetric economic impact of Covid-19 pandemic on Indian states. The study uses PCA methodology to determine the state-wise Economic activity index and state-wise mobility index. The study reveals that the economic structure of the state plays a significant role as the recovery trajectory of covid-19 pandemic is concerned. Results clearly depicts that states with higher share of agriculture in GSVA witnessed lesser contraction in economic activities than states with higher share of industry and services in GSVA.

There are lot of literature available on the impact of Covid-19 pandemic on Indian economy as well as agriculture sector at national level. There are very rare study available of Covid-19 pandemic on agriculture sector in Uttar Pradesh. It is in this context, the present paper examines the impact of Covid-19 on agriculture sector in Uttar Pradesh at farm household level. Moreover, the present study tries to examine the impact of Covid-19 on agricultural output/ crop production and farm inputs and also analysis the trends of price of crop production and farm inputs cost during this pandemic at farm household level.

III. METHODS AND DATABASE

Methods: Uttar Pradesh is divided into four administrative regions, namely Western Uttar Pradesh (WUP), Eastern Uttar Pradesh (EUP), Central Uttar Pradesh (CUP) and Bundelkhand, and nine agro-climate zones, viz., Terai, Western Plains, Mid-Western Plains, Western Semi-Dry Plains, Mid-Western South Plains, South-Western Semi-Dry Plains, North Eastern Plains, Vindhyachal and Bundelkhand. There are very wide regional/ climatic variations across the state. In the present study, two regions viz., Western Uttar Pradesh and Bundelkhand has been selected for farm household survey. Bundelkhand is drought-prone region and Western Uttar Pradesh is highly developed agriculture sector of the state. For the assessment the impact of covid-19 on agriculture sector of Uttar Pradesh, primary data in different districts has been collected from farm household. Six districts of the state namely, Meerut, Baghpat, Amroha, Jhansi, Lalitpur and Bulandshahr were selected purposively. In each district, 2 blocks were selected and one village were selected from each block. 30 schedules from each village have been filled at farm household. Therefore, the study is based on primary household survey of 360 farmers. For this study, convenient sampling procedure was used. The primary data for this study was collected last quarter of 2022. It covers both waves of Covid-19 pandemic in India. All the farmers were individually interviewed through pre tested schedule, so that original picture of impact of Covid-19 could be drawn. Responses received from the farmers were analysed by using SPSS software and simple statistical techniques has been used for analysis. The details of selected districts are given in Figure 1.



Selected Districts Indicate by Green Color

FIGURE 1: Map of Area of study at Regional and Farm Levels in Uttar Pradesh

Source: Author's classification

Database: The database for the present paper was collected from various secondary data sources such as Directorate of Economics and Statistics, Department of Agriculture and Farmer's Welfare, Ministry of Agriculture and Farmer's Welfare, Government of India, Reserve Bank of India Handbook of Statistics on Indian States, Government of India, Uttar Pradesh Directorate of Economics (UPDES), Government of Uttar Pradesh and Statistics, Government of Uttar Pradesh.

IV. RESULT AND DISCUSSION

Agricultural Growth Trends in Uttar Pradesh: The agricultural output growth trend of India as well as Uttar Pradesh from 2011-12 to 2021-22 are presented in Figure 2 and Figure 3 respectively. This Figure 2 depicts the trends of agriculture, forestry and fishing output in India. The data depicts that there is consistent increase in the gross value of output, with average output

increasing between the time periods 2015-2022. During the pandemic period i.e. 2020-2021, the result shows that there are steep decline from quarter 3 (2019-2020) to quarter 3 (2020-2021) with absolute values greater than previous period.

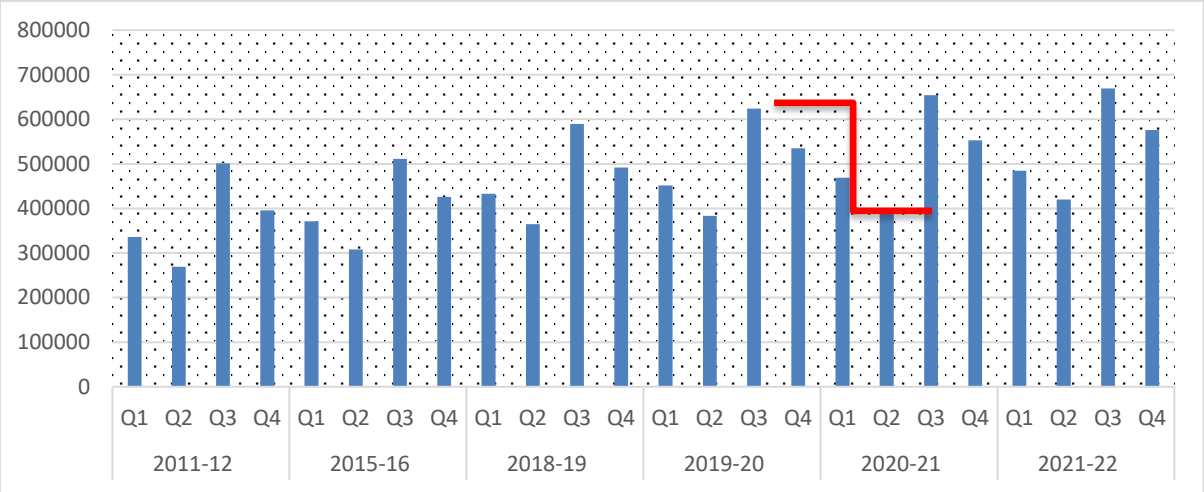


FIGURE 2: Trends of Agriculture, Forestry & Fishing Output in India (Rs. Crore)

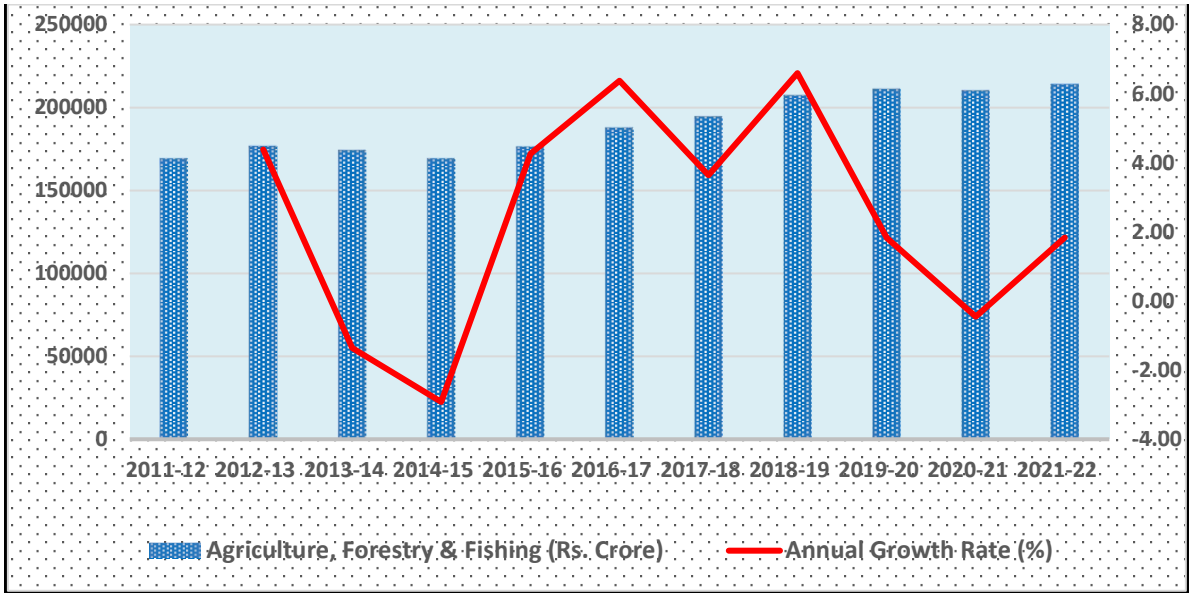


FIGURE 3: Trends of Agriculture, Forestry & Fishing Output in Uttar Pradesh

Figure 3 depicts the trends of agriculture, forestry and fishing output in Uttar Pradesh. The data shows that there is consistent increase in the gross value of output with annual growth rate before pandemic period, with an exception of period 2014-2015. After 2014-15 rapid growth is seen in output and annual growth rate. The figure shows that there is consistent increase in absolute value of output with increase in annual growth rate throughout the years but due to worse impact of Covid-19 pandemic agriculture sector hit badly. There is growth declining in pandemic period i.e. 2020-2021. Although overall economic growth declined by 7.2 per cent but agriculture and allied sectors report a growth of 3.4 per cent during the lockdown.

Results and Discussion based on Primary Database: Table 1 represents the responses of farm household of selected district of Uttar Pradesh about the impact of Covid-19 on the agricultural output viz., crop sector, animal husbandry, fisheries, logging & forestry and poultry and their prices. The crop sector reported an increase as per 18.84 per cent respondents in the output. On the other hand, 65.80 per cent farmers responded that the agricultural output has decreased, whereas the output remained unchanged for 15.36 per cent. Similarly, 28 per cent reported that the output prices as regards to crops have increased. But 66 per cent farmers responded that output prices of crops have decreased. In animal husbandry, the output reported a decline as per 48 per cent respondents; however, 35per cent reported no change in the output in animal husbandry. The output has increased according to 18 per cent farmers only. Similarly, 28.41 per cent reported that the output prices as regards to animal

husbandry have increased. But 66.38 per cent farmers responded that output prices of animal husbandry have decreased. The fisheries sector reported an increase as per 12.33 per cent respondents in the output. On the other hand, 66.0 per cent farmers responded that the fisheries output has decreased, whereas the output remained unchanged for 21.59 per cent.

TABLE 1
IMPACT OF COVID-19 ON THE AGRICULTURAL OUTPUT AND ITS PRICES

Agriculture Sub-Sector	Impact	Impact on Agriculture Output		Impact on Agriculture Output Price	
		Frequency	Per cent	Frequency	Per cent
Crops	Increase	65	18.84	98	28.41
	Decrease	227	65.80	229	66.38
	No Change	53	15.36	18	5.22
Animal Husbandry	Increase	61	17.68	93	26.96
	Decrease	164	47.54	220	63.77
	No Change	120	34.78	32	9.28
Fisheries	Increase	28	12.33	40	17.62
	Decrease	150	66.08	125	55.07
	No Change	49	21.59	62	27.31
Logging and Forestry	Increase	33	14.73	40	18.02
	Decrease	135	60.27	115	51.80
	No Change	56	25.00	67	30.18
Poultry	Increase	35	15.42	42	18.92
	Decrease	134	59.03	121	54.50
	No Change	58	25.55	59	26.58

Source: Author's calculation based on primary household survey

Similarly, 17.62 per cent reported that the output prices as regards to fisheries have increased. But 55.07 per cent farmers responded that output prices of Fisheries have decreased. The logging and forestry sector reported an increase as per 14.77 per cent respondents in the output. On the other hand, 60.27 per cent farmers responded that the logging and forestry output has decreased, whereas the output remained unchanged for 25.0 per cent. Similarly, 18.0 per cent reported that the output prices as regards to logging and forestry have increased. But 51.80 per cent farmers responded that output prices of logging and forestry have decreased. However, 30.18 per cent farmers have responded that there is no change in the price. The poultry sector reported an increase as per 15.42 per cent respondents in the output. On the other hand, 59.03 per cent farmers responded that the poultry output has decreased, whereas the output remained unchanged for 25.55 per cent. Similarly, 18.92 per cent reported that the output prices as regards to poultry have increased. But 54.50 per cent farmers responded that output prices of poultry have decreased. However, 26.58 per cent farmers have responded that there is no change in the price.

The Impact of Covid-19 on the agricultural/ farm Inputs and their price level with the help of selected farm household of Uttar Pradesh are presented in Table 2.

TABLE 2
IMPACT OF COVID-19 ON THE AGRICULTURAL/ FARM INPUTS AND ITS PRICES

Agricultural Inputs	Impact	Impact on Availability of Agricultural inputs		Impact on Prices of Agricultural inputs	
		Frequency	Per cent (%)	Frequency	Per cent (%)
Fertilizers	Increase	43	12.43	249	71.97
	Decrease	205	59.25	44	12.72
	No Change	98	28.32	53	15.32
Pesticides	Increase	37	10.69	237	68.50
	Decrease	187	54.05	32	9.25
	No Change	122	35.26	77	22.25
Rental Agro-machinery	Increase	36	10.40	208	60.12
	Decrease	158	45.66	33	9.54
	No Change	152	43.93	105	30.35
Fodder/Cattle feed	Increase	39	11.27	226	65.32
	Decrease	158	45.66	37	10.69
	No Change	149	43.06	83	23.99
Seeds	Increase	40	11.56	248	71.68
	Decrease	177	51.16	21	6.07
	No Change	129	37.28	76	21.97
Fuel	Increase	73	21.10	251	72.54
	Decrease	157	45.38	26	7.51
	No Change	115	33.24	69	19.94

Source: Author's calculation based on primary household survey

The availability of fertilizers reported an increase as per 12.43 per cent respondents. On the other hand, 59.25 per cent farmers responded that availability of fertilizers has decreased, whereas the availability of fertilizers remained unchanged for 28.32 per cent. Similarly, 71.97 per cent reported that prices as regards to fertilizers have increased. But 12.72 per cent farmers responded that prices of fertilizers have decreased. The availability of pesticides reported an increase as per 10.69 per cent respondents. On the other hand, 54.05 per cent farmers responded that availability of pesticides has decreased, whereas the availability of pesticides remained unchanged for 35.26 per cent. Similarly, 68.50 per cent reported that prices as regards to pesticides have increased. But 9.28 per cent farmers responded that prices of pesticides have decreased. The availability of rental agro-machinery reported an increase as per 10.40 per cent respondents. On the other hand, 45.66 per cent farmers responded that availability of rental agro-machinery has decreased, whereas the availability of rental agro-machinery remained unchanged for 43.93 per cent. Similarly, 60.12 per cent reported that prices as regards to rental agro-machinery have increased. But 9.54 per cent farmers responded that prices of rental agro-machinery have decreased. However, 30.35 per cent farmers have responded that there is no change in the price.

The availability of fodder/cattle feed reported an increase as per 11.27 per cent respondents. On the other hand, 45.66 per cent farmers responded that availability of fodder/cattle feed has decreased, whereas the availability of fodder/cattle feed remained unchanged for 43.06 per cent. Similarly, 65.32 per cent reported that prices as regards fodder/cattle feed have increased. But 10.69 per cent farmers responded that prices of fodder/cattle feed have decreased. However, 23.99 per cent farmers have

responded that there is no change in the price. The availability of seeds reported an increase as per 11.56 per cent respondents. On the other hand, 51.16 per cent farmers responded that availability of seeds has decreased, whereas the availability of seeds remained unchanged for 37.28 per cent. Similarly, 71.68 per cent reported that prices as regards to seeds have increased. But 6.07 per cent farmers responded that prices of seeds have decreased. However, 21.97 per cent farmers have responded that there is no change in the price. The availability of fuel reported an increase as per 21.10 per cent respondents. On the other hand, 45.38 per cent farmers responded that availability of fuel has decreased, whereas the availability of fuel remained unchanged for 33.24 per cent. Similarly, 72.54 per cent reported that prices as regards to fuel have increased. But 7.51 per cent farmers responded that prices of fuel have decreased. However, 19.94 per cent farmers have responded that there is no change in the price.

Figure 4 represents the responses of selected farm household of the study about the impact of Covid-19 on the agricultural output and results reveal that covid-19 pandemic had significant impact on the production of agriculture and its allied sector. Many factors such as restrictions on the movement of labor and machinery, interruptions in the supply chain of commodity and lockdown imposed to curb the fast growing impact of the pandemic contributed to the fluctuations in agriculture sector. Out of total responding farmers, 69.0 per cent reported a decrease in the agricultural output. On the other hand only 9.0 per cent reported an increase in the output. The agricultural output remained same for 22.0 per cent respondents.

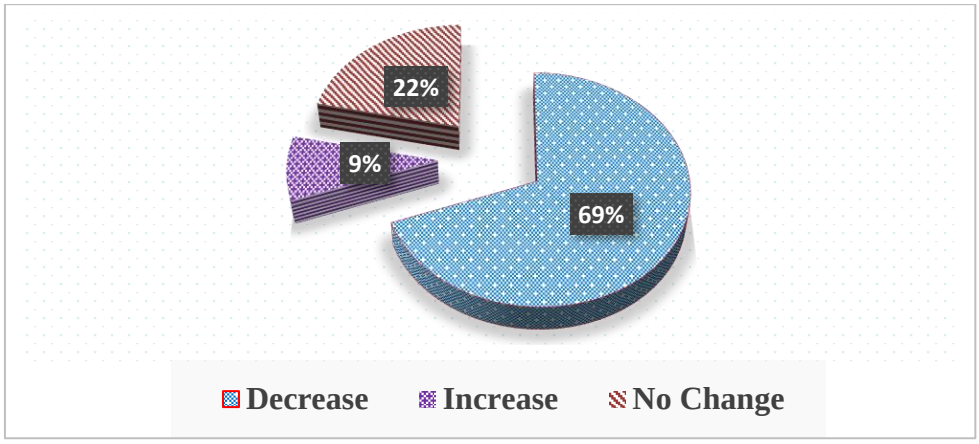


FIGURE 4: Impact of Covid-19 on Agricultural Output

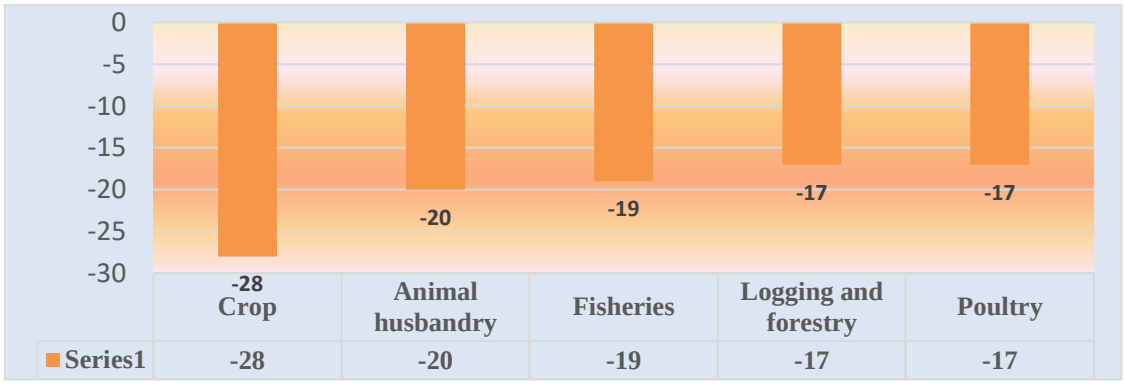


FIGURE 5: Decrease in Production in Agriculture and Allied Sector (in per cent)

The responses to the decrease in production in Agriculture and Allied Sector (in per cent) are presented in Figure 5. To have a detailed analysis of impact of pandemic on the agriculture allied sector, the study has bifurcated the allied sector into Crop, Animal husbandry, Fisheries, Logging and forestry, Poultry. The production of Crop, Animal husbandry, Fisheries, Logging and forestry, poultry has decreased according to 28.0 per cent, 20.0 per cent, 19.0 per cent, 17.0 per cent, 17.0 per cent respectively. The sector with the most evident and strong impact is Animal husbandry with 38.0 per cent production declining in the range of 0-25 per cent. It is followed by crops with the decline of 35.0 per cent in the range of 0-25 per cent. Similarly decline of 30.0 per cent, 28.0 per cent, and 28.0 per cent was recorded in fisheries, logging and forestry, poultry respectively.

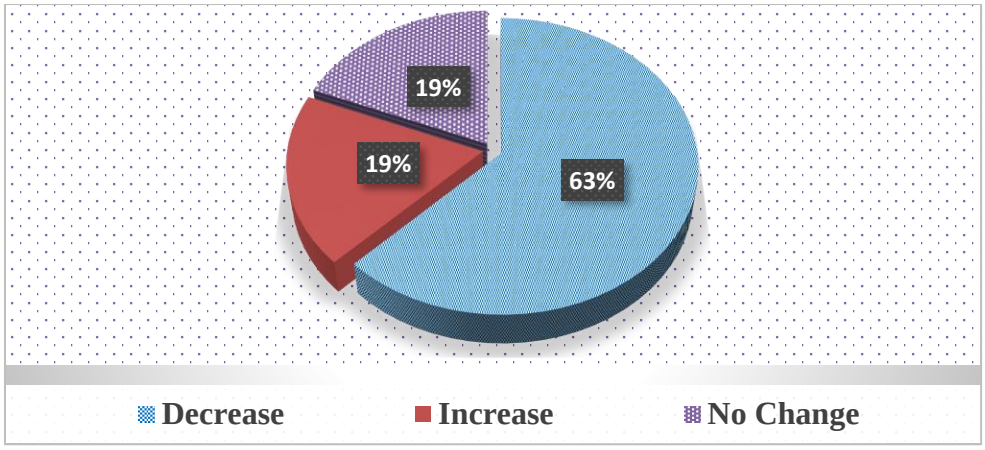


FIGURE 6: Responses for Change in Overall Prices of Agricultural Commodities (in per cent)

Figure 6 represents the responses for change in overall prices of agricultural commodities (in per cent). As stated above that 69.0 per cent of the farmers reported a decline in the production of agriculture commodities. This reduction in the production along with decreased demand (inadequate money with the consumer to demand), lockdown, and disrupted supply chain fueled the miseries of the farmers. 62.0 per cent of the farmers responded that there is a decrease in the prices of the commodities. Furthermore, only 19.0 per cent respondents reported that the output prices have increased. Similarly, 19.0 per cent reported no change in the output prices. Besides decline in the agricultural production, decrease in the output prices has added to the ever increasing miseries of the farmers.

The response of farm respondent regarding decrease in output prices of commodities in agriculture and allied sectors (in per cent) are given in Figure 7.

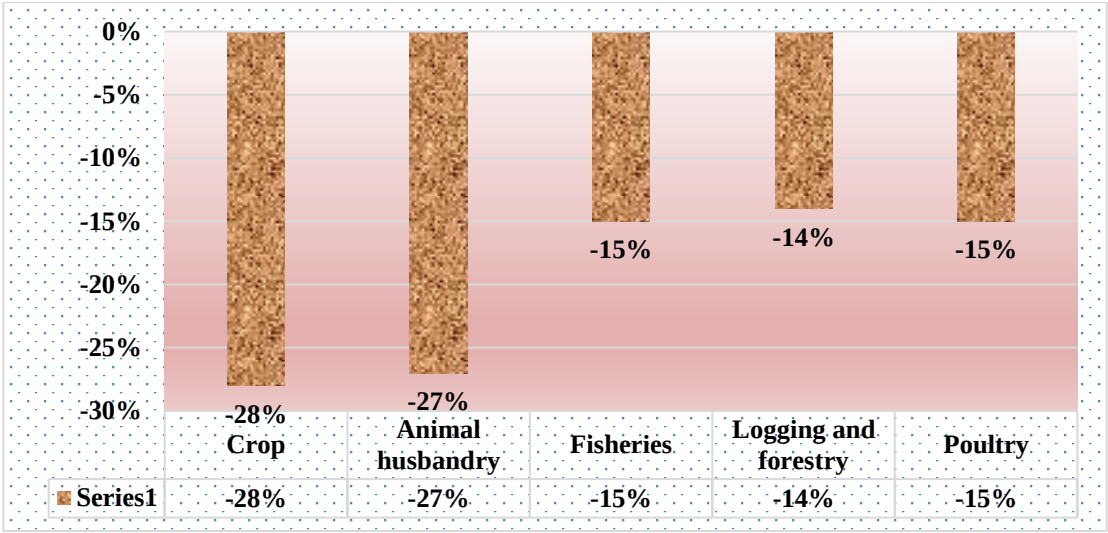


FIGURE 7: Decrease in Output Prices of Commodities in Agriculture Sectors (in per cent)

Considering the allied sectors of the agriculture the output prices have decreased across all sectors. The most notable decline was in the Crop sector (28.0 per cent), followed by decline in Animal husbandry (27.0 per cent) due to decreased opportunities available to farmers to trade their commodities. The market places and shops were closed down; there was minimal demand for the commodities which resulted in low output prices. The minimum decline in prices was perceived in logging and forestry sector (14.0 per cent) and poultry and fisheries sector (15.0 per cent) respectively. The fall in output prices could be credited to decrease in demand for such commodities and disruptions in mobility of agricultural output due to ban on movement of vehicles.

The response of farm respondent regarding change in overall availability of agriculture/ farm inputs (in per cent) in agriculture and allied sectors are given in Figure 8. The farm household responses indicate that around 58.0 per cent cases, the availability of agriculture/ farm inputs have been decreased.

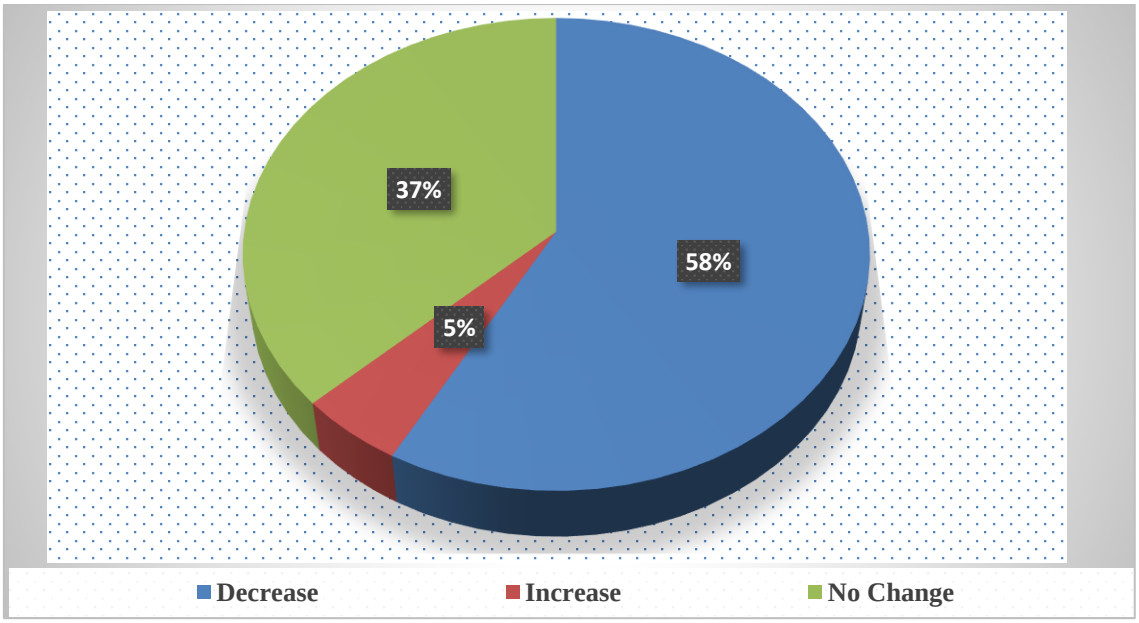


FIGURE 8: Responses for Change in Overall Availability of Farm Inputs (in per cent)

Figure 9 represents the responses for decrease in the availability of agricultural inputs (in per cent).This part of the study analysis the impact of pandemic on the overall availability of agricultural inputs such as Fertilisers, Pesticides, Rental Agriculture machinery, Fodder/cattle feeds, Seeds, Fuel. The availability of inputs has decreased as responded by 58.0 per cent of the farmers. According to only 5.0 per cent respondents the input availability has increased. The availability of agricultural inputs has remained same for 37.0 per cent respondents.

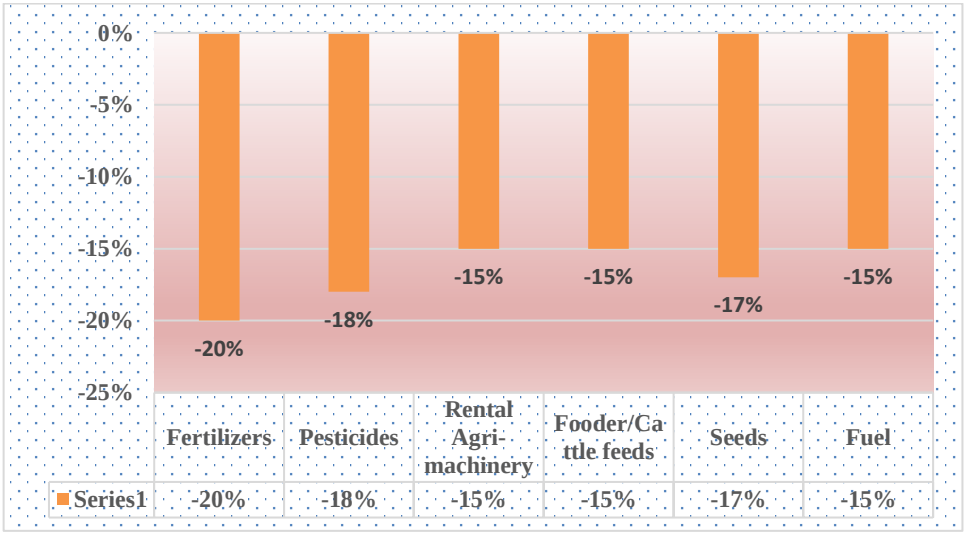


FIGURE 9: Decrease in the Availability of Agricultural/ Farm Inputs (in per cent)

After analysing the impact of pandemic on farm inputs individually, it can be reported that the availability of Fertilisers was the most affected by the pandemic. The most intense decline was in the availability of fertilizers (20.0 per cent) accompanied by pesticides (18.0 per cent), seeds (17.0 per cent). Significant decline was recorded in the availability of rental agro-machinery, fodder and fuel (15.0 per cent). The availability of fertilisers has declined in the range of 25-50 per cent as per 41.0 per cent respondents. Similarly, in the range of 25-50 per cent the availability of pesticides, rental agricultural machinery, fodder/cattle feeds, seeds, and fuel is recorded to decline as per 38.0 per cent, 37.0 per cent, 40.0 per cent, 36.0 per cent, and 36.0 per cent respondents respectively.

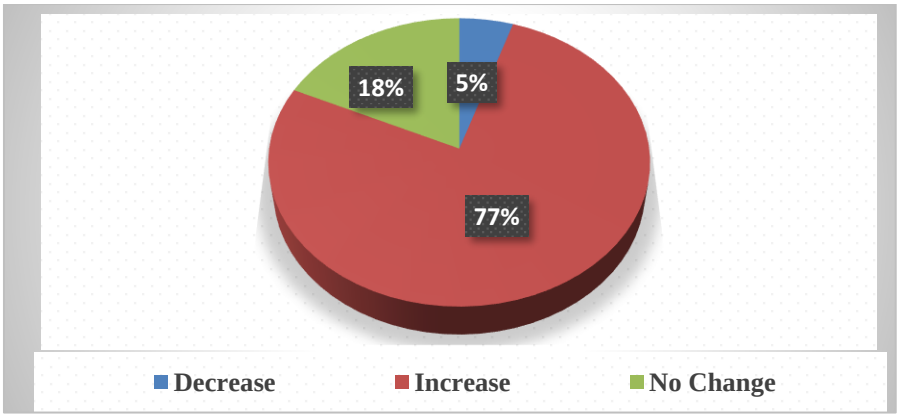


FIGURE 10: Responses for Change in Overall Prices of Agricultural/ Farm Inputs (in per cent)

The responses of farm respondent regarding change in overall prices of agricultural/ farm inputs (in per cent) in agriculture and allied sectors are given in Figure 10. The prices of agricultural inputs increased substantially in most of the sample districts. As apparent from the analysis made above, the availability of agricultural inputs had declined. This decline in the availability of the agro-inputs resulted in higher prices of the inputs. The overall prices of agricultural inputs increased as per 77.0 per cent of the respondents, while 5.0 per cent reported a decrease in the input prices. In 18.0 per cent of the selected samples the prices of agricultural inputs remained unchanged.

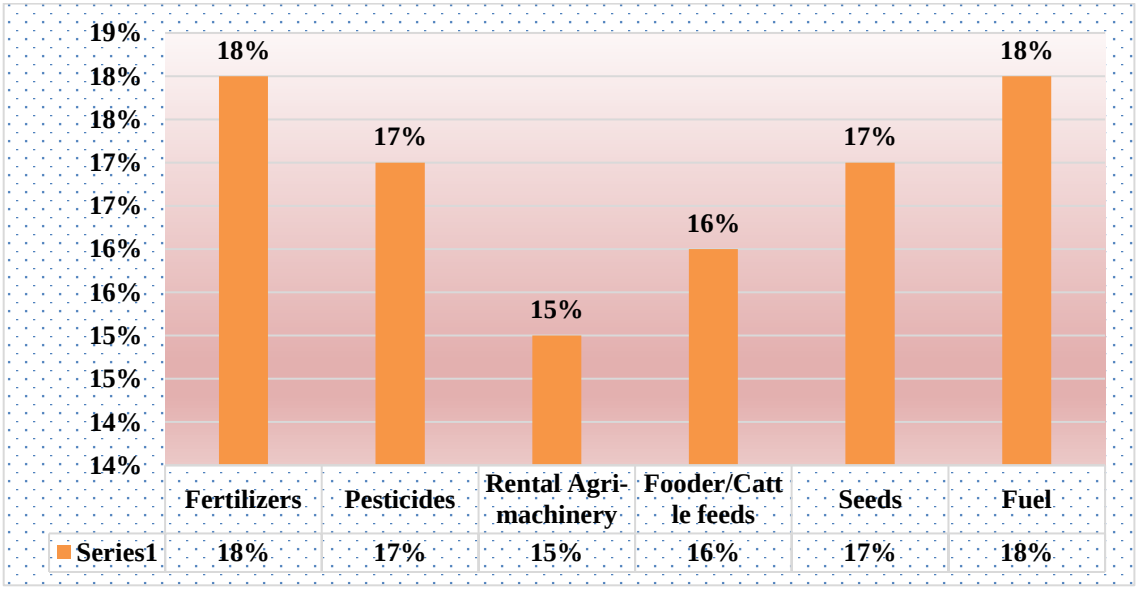


FIGURE 11: Response for Increase in Prices of Agricultural/ Farm Inputs (in per cent)

The responses of farm respondent regarding increase in prices of agricultural/ farm inputs (in per cent) in agriculture and allied sectors are given in Figure 11. All in all majority of the inputs had witnessed an increase in the magnitude of the prices. The highest increase in prices can be seen in the case of fertilizers and Fuel (18.0 per cent each), followed by pesticides and seeds (17.0 per cent), fodder/cattle feed (16.0 per cent), rental agro-machinery (15.0 per cent). The increase in prices of agricultural inputs can be attributed to low availability due to disruption in supply, shut down of markets, restrictions on the movement of material. The input prices of fertilisers have increased in the range of 0-25 per cent as per 50.0 per cent respondents. Similarly, in the range of 0-25 per cent the input prices of pesticides, rental agricultural machinery, fodder/cattle feeds, seeds, and fuel is recorded to increase significantly.

V. CONCLUSION AND POLICY IMPLICATIONS

Although overall impact of Covid-19 pandemic on Indian economy is quite harsh, there is agriculture sector which records positive growth rate during both Covid-19 waves, however, industrial and service sector suffered significantly. According to the findings, major impact of Covid-19 is observed on fisheries and poultry, due to the widespread fear of fishes being the

vector of the contagious disease. Covid-19 has no impact on agricultural output as per 22.0 percent respondents whereas it has increased by 9.0 percent farmers. The agricultural output declined as per 69.0 percent respondents, the reason behind declined output were strict restrictions imposed on the labour, machinery movement and supply of various inputs. As regards availability of inputs, 37.0 percent farmers reported that there was no impact on the availability of inputs during pandemic , whereas 58.0 percent reported that there has been decline in availability of inputs .The prices of inputs remained same for 18.0 percent respondents, 5.0 percent reported a decline and 77.0 percent said that the prices of inputs increased due to disruption in movement of men and machinery, prevalent corruption in distribution of inputs such as fertilizers, pesticides, seeds etc.. The study revealed that the performance of agriculture sector in Western Uttar Pradesh is more satisfactory than the Bundelkhand region of the state. The present study suggests that the agricultural infrastructural facilities, effective digitalization of agro activities and integrated agriculture cold chain need to be improved for mitigating the losses caused by the pandemic. Agriculture sector being a prominent sector for the revival of the economy from the aftermath of the pandemic needs more attention of the policy makers. To overcome the issues faced by farmhouse hold and to prevent such happenings in the future, we need to ensure that the market mechanism for agricultural inputs and output need to be more effective and free from every form of evil which could hinder the growth of agricultural sector. The inclusion of farmers under government initiatives such as e-NAM, National Mission for Sustainable Agriculture (NMSA), Livestock Insurance Schemes needs to be increased to revitalize agriculture sector and to improve their economic conditions.

ACKNOWLEDGEMENTS

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Studies on Development of Nutritionally Enriched Banana Flour Ladoo

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Abstract— *Food based approaches are recognized as in essential part of an urgently needed more comprehensive strategy for improving nutrition by increasing the availability and consumption to combat nutrient deficiencies. Banana flour ladoo was developed and standardized largely for the children, adolescence and lactating mothers. The present study is carried out to develop a nutritionally enriched banana ladoo. The banana flour ladoo was composed of banana flour, pearl millet, flax seed, Moringa powder, palm jaggery and desi cow ghee. Banana flour was taken in the form of three different compositions and control form (50%,60%, 70% and 100%) & analyzed for sensory physio- chemical, textural and color analysis. The results obtained that banana flour ladoo with treatment 3 (70 % of banana flour, 15 % of pearl millet flour, 13 % of flax seed powder, 2% of Moringa powder, 80% palm jaggery and 20% of desi cow ghee) is more acceptable and nutritious compared to treatment -1, treatment -2 and control (banana flour). It has protein content of 11.34 grams, carbohydrates 97.24, moisture 3.5 and ash 4%. The hardness of banana flour ladoo treatment 3 is 60 g which is lowest value compared to other treatments. The treatments of banana flour ladoos are packed in LDPE pouches and stored at room temperature (27°C). Hence it may be recommended that banana flour ladoo could be healthy value added product and overcome from certain nutrient deficiency.*

Keywords— Flour Ladoo, Palm Jaggery, banana, Millet, flax seed.

I. INTRODUCTION

India is the largest producer of bananas in the world with a production of 297 lakh metric tonnes on 8.4 lakh hectares of land according to an estimate, 290 lakh metric tonnes (97%) is consumed domestically, while another 5 lakh metric tonnes or so is lost due to bananas perishability.The majority of banana exports from India are to west Asian and north African countries like UAE, Bahrain, Egypt, Saudi Arabia, Qatar and Iran. The banana variety that grown in Kadapa district is Grand Nain. These are banana cultivars of Musa acuminata. It is one of the most commonly Cavendish banana cultivar group. It is also known as the Chiquita banana because it is the main product of Chiquita brands international. Banana fruits are the major source of energy-producing carbohydrates, potassium, vitamin-b6, vitamin c, dietary fibre, antioxidants and minerals such as potassium, magnesium, sodium and phosphorus. Bananas have no fat, cholesterol or salts and therefore make an excellent food rich in nutritional substances and ideal as a snack for both children and adults. Palm Jaggery also known as Taad Gud (Taar Gur) in Hindi and Karuppatti It was originally made from the sugary sap of the Palmyra Palm. The taste of the Palm Jaggery which is made from the coconut juice has a chocolate-like taste which makes it a great substitute to refined sugar Palm Jaggery which is made from Palm tree extract has a number of minerals and vitamins. They have a large number of medicinal properties, which also acts a healthy and natural sweetener. Palm Jaggery is an incomparable substitute of refined sugar. When comparing it to the refined sugar, the nutrient of palm jaggery remains in it even after the manufacturing process is completed. Palm Jaggery intensifies the taste of many dishes in India because it provides both sweet and savoury flavour. The leaves of the Moringa oleifera tree are very nutritious. They can be consumed fresh, cooked or dried. Since dried Moringa leaves retain their nutrient content, it is possible to convert them into leaf powder. Moringa Leaf Powder is an excellent nutritional supplement and can be added to any dish. Moringa contain high amount of vitamins, calcium, iron, potassium, antioxidants and all essential

amino acids in a good proportion which are the building blocks of protein. The dried powder Moringa leaves have high level of vitamin E, Beta-carotene. Beta- carotene most potent precursor of vitamin A. Drying the leaves assist to concentrate the nutrients, facilitate conservation and consumption. Flaxseed is the seed from the flax plant, an annual herb, which is a member of the Linaceae family. The whole flaxseed is flat and oval with pointed tips and contains a seed coat or true hull (also called testa), a thin endosperm, two embryos and an embryo axis. Every part of the linseed plant is utilized commercially, either directly or after processing. The shell yields good quality fiber having high mechanical properties and low density instead the seed provides oil rich in omega-3, digestible proteins and lignans; it is also use to manufacture paints, varnishes, linoleum, oilcloths, printing inks, soaps and numerous other products. Bajra (Pearl Millet) is an important crop in India and it is the largest producer of bajra in the world. Bajra is rich in proteins, vitamins and minerals like iron and calcium. It has high calorific value and hence it is grounded into flour and is used in making various products like Breads, Cookies, and Biscuits. Bajra consumption prevents anaemia and promotes a healthy nervous system. It helps to overcome acidity due to its alkaline nature. Hence, Bajra is used as ingredient for protein enrichment. It is good for digestion and has antibacterial, antifungal and antioxidant properties. Ghee contains 99-99.5 % fat and less than 0.5% moisture. Contains fat soluble vitamins (A, D, E, and K) and essential fatty acids. Cow ghee is preferable to buffalo ghee because it has carotene vitamin A which is good for eye and brain function buffalo ghee has more fats and calories as compared to cow ghee.

II. MATERIALS AND METHODS

The present study entitled "Development and Quality evaluation of Nutritionally Enriched Banana Flour Ladoo" was attempted to analyze the texture and appearance of the Banana flour ladoo enriched with Palm Jaggery. The fruits are graded in the farm based on size and shape. The Fruits were weighted and washed with tap water. Remove the peel of raw bananas and cut into slices using slicer. Dry the slices in cabinet dryer at 60°C for 24 hours. The whole grains of bajra were graded and roasted at 180°C. After cooling, the grains were milled to obtain bajra flour. The flax seed were graded and roasted at 180°C. After cooling, the seed were milled to obtain flax seed powder. The moringa leaves were washed and steam blanched for 80°C for 1 minute. The blanched leaves were dried in solar dryer for 12 hours. Different compositions were used for different treatments. The compositions of raw banana flour used are 50%, 60% and 70% for preparation of ladoo.

2.1 Estimation of Proteins:

Protein content of sample was quantified by the kjeldahl technique with a conversion factor of 6.25.

2.1.1 Estimation of total carbohydrates by anthrone method:

Acidic medium glucose is dehydrated to hydroxy methyl furfural. This compound forms with anthrone a green coloured product with an absorption max at 630 nm.

2.1.2 Estimation of ash:

To determine ash content, the sample of 2.5g was used to expose the sample in a mufÒe furnace by following Horwitz and Latimer (2005).

2.1.3 Estimation of moisture content:

The moisture content of the banana flour laddoo was determined based on dry basis (PFA). It is based on the separation of water from the food material and its measurements by the resulting loss in weight or by measurement of the amount of water separated. The removal of water can be accomplished by drying procedure. Take the weight of Petri dish with lid. Weigh about 5gms of each sample into the Petri dish and spread evenly for uniform drying. Leave the Petri dish in an oven at 130˚C with the lid open for about 2 hours. Cool the Petri dish in a desiccator for 1-2 hours. Take the weight of the Petri dish. Repeat process of heating and cooling until a constant Weight is achieved.

2.1.4 Estimation of colour:

Banana flour ladoo was measured by a Hunter Lab Colour meter (M/s Colorflex, 45/0, Hunter Lab Reston, VA, USA). Before measuring sample colour, the instrument was calibrated using a standard white plate followed by a black plate as described in user manual.

Instrumental values L*, a* and b* indicate lightness, redness/ greenness, and yellowness/blueness, respectively.

2.2 Texture profile analysis:

Banana flour ladoo was instrumentally conducted using a Brookfield texture analyzer (Model CT3, Middleboro, USA). The instrument was designed with 10 kg load cell with different probes for measurement of textural properties of food products. A cylindrical probe of (diameter 4 mm cylindrical/TA44) was used with 5 mm target distance test conditions, one mm/s test and post-test speed with trigger load 7g. Texture Pro CT V1.6 software (M/s Brookfield Engineering Labs) was deployed to assess textural attributes.

2.3 Sensory evaluation:

The sensory attributes of developed banana flour ladoo were evaluated with expert panel members. After every sample scoring, ladoo samples were served to panel members with coded identities and tasted for organoleptic properties by rinsing tongue with purified water.

III. RESULTS AND DISCUSSION

3.1 Protein:

The protein contents of the sample were determined using kjeldhal method. The protein contains of banana flour ladoo ere compared with the control and the results are expressed as the following table 1.

TABLE 1
PROTEIN VALUES FOR DEVELOPED BANANA FLOUR LADOO

S. No	Particulars	Protein content (gm)
1	Control (100% BF)	4.76
2	Treatment – 1 (50% BF)	12.47
3	Treatment – 2 (60% BF)	11.82
4	Treatment – 3 (70% BF)	11.34

3.2 Carbohydrates:

The carbohydrate content of the sample was determined by using Anthrone method. The carbohydrate contents of banana flour ladoo were compared with the control and the results are expressed as the following table 2. Treatment 3 showed highest value than other treatment banana flour ladoos, which is recommendable for better carbohydrate content.

TABLE 2
CARBOHYDRATE VALUES FOR DEVELOPED BANANA FLOUR LADOO

S. No	Particulars	Carbohydrate Content (grams)
1	Control	88.28
2	Treatment – 1 (50% BF)	80.07
3	Treatment – 2 (60% BF)	94.92
4	Treatment – 3 (70% BF)	97.24

3.3 Ash Content:

The ash content of the sample were determined by using Muffle furnace. The ash contents of banana flour ladoo were compared with the control and the results are expressed as the following table 3. Treatment 3 showed highest value than other treatment banana flour ladoos, which is recommendable for better minerals.

TABLE 3
ASH VALUES FOR DEVELOPED BANANA FLOUR LADOO

S. No	Particulars	Ash content (%)
1	Control	2%
2	Treatment – 1 (50% BF)	3.50%
3	Treatment – 2 (60% BF)	1.50%
4	Treatment – 3 (70% BF)	4.10%

3.4 Moisture Content:

Determination of moisture content is the most important and fundamental analysis that can be performed on a food product. Moisture content of developed banana flour ladoo were compared with control and the results are expressed as the following fig 1. Treatment 3 sample showed lowest value than other treatment banana flour ladoos, which is recommendable for better shelf life.

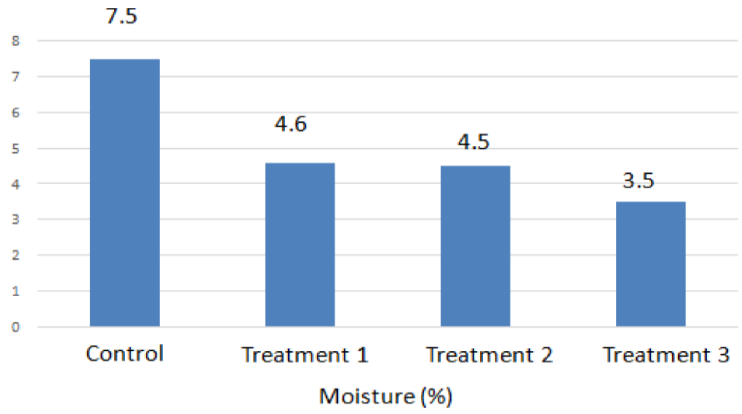

FIGURE 1: Moisture content of Banana flour ladoo

3.5 Colour:

The Colour values of the developed banana flour ladoos are presented in the following table 4. With the increase in the proportion of green banana flour, a decrease in whiteness was observed by Mabogo *et al.* (2021). Treatment 3 was shown better colour compared to other treatments.

TABLE 4
COLOUR VALUES FOR DEVELOPED BANANA FLOUR LADOO

S.No	Particulars	L*	a*	b*	ΔE*
1	Control	73.3	3.54	15.1	313.84
2	Treatment – 1 (50% Banana flour)	45.3	3.69	25.62	715.3
3	Treatment – 2 (60% Banana flour)	55.64	2.61	24.67	671
4	Treatment – 3 (70% Banana flour)	53.05	4.37	25.21	707.67

3.6 Texture Profile Analysis:

Textural profile of food product indicates various attributes which are beneficial in design of any food formulation. Hardness of banana flour ladoo is one of the important attribute of which governs biting difficulty by consumer. The order of hardness in increasing order is T3>T2>T1>Control. The values are shown in table 5 and figures 2, 3, 4 and 5.

TABLE 5
TEXTURE ANALYSIS VALUES OF DEVELOPED BANANA FLOUR LADOO

Samples	Hardness
Control	160
Treatment 1	90
Treatment 2	65
Treatment 3	60

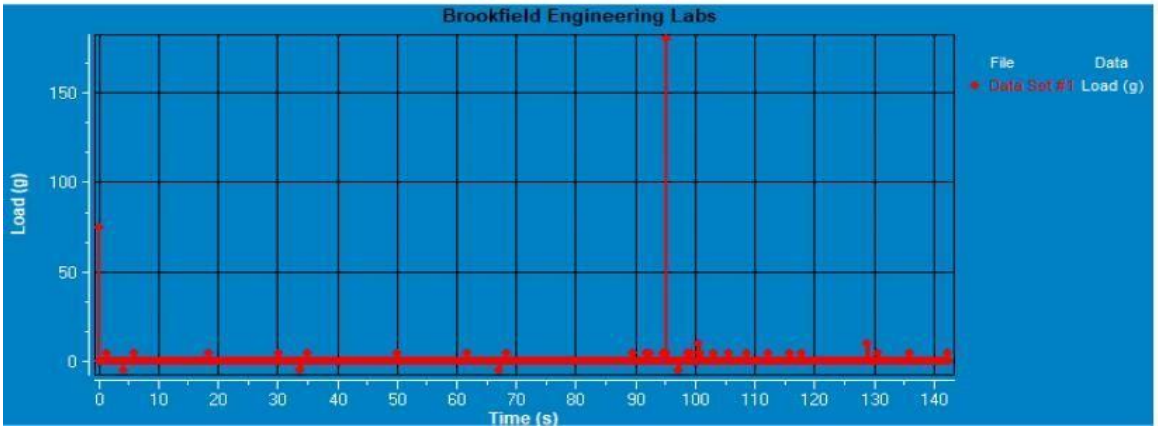

FIGURE 2: Texture profile analysis of control banana flour ladoo

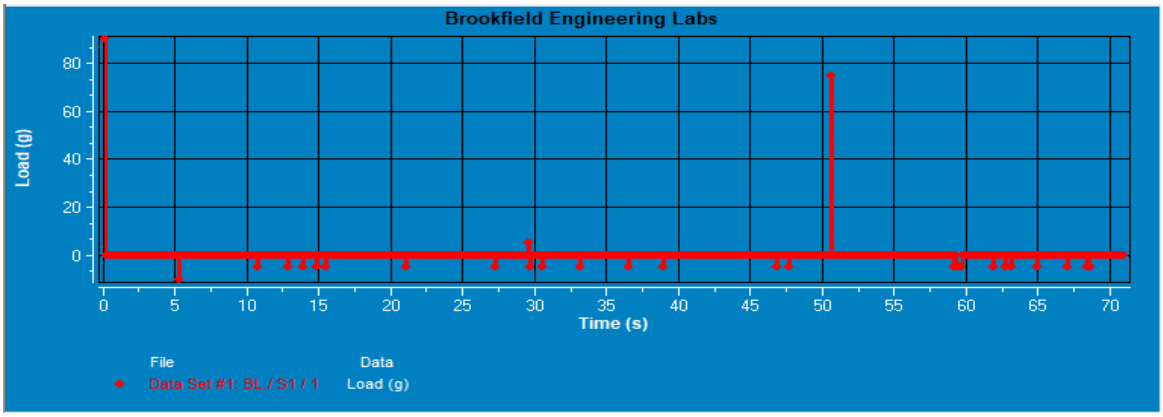

FIGURE 3: Texture profile analysis of Treatment – 1 banana flour ladoo

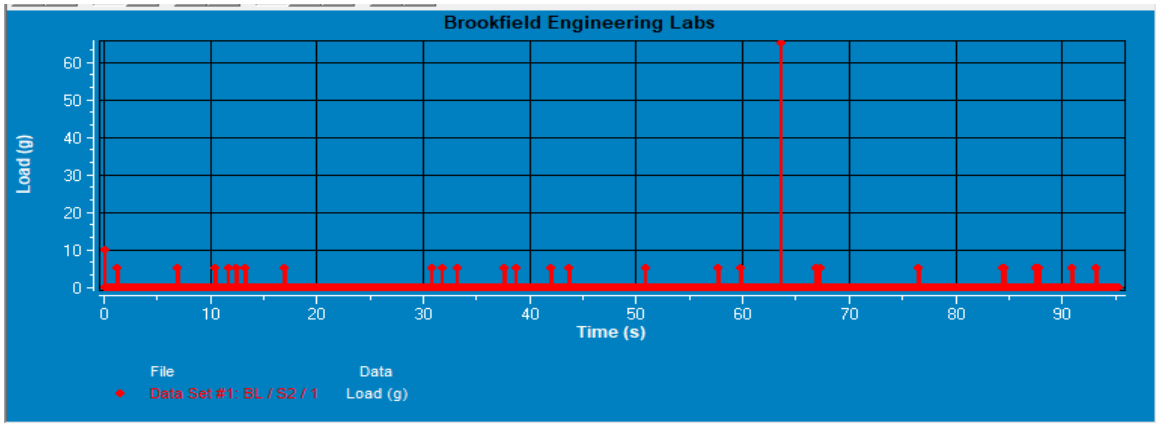

FIGURE 4: Texture profile analysis of Treatment – 2 banana flour ladoo

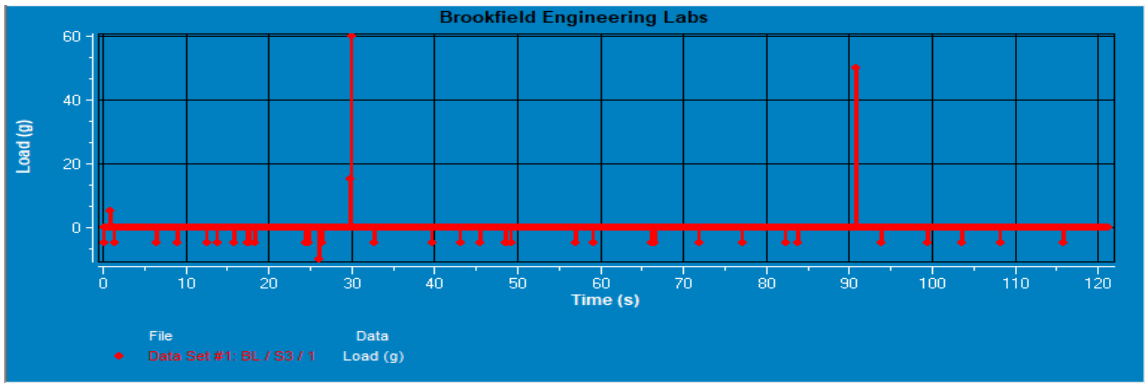

FIGURE 5: Texture profile analysis of Treatment – 3 banana flour ladoo

3.7 Sensory Evaluation:

The quality characteristics such as appearance, flavor, texture, taste and overall acceptability were analyzed by using the 9-point hedonic scale. The consumer acceptance of the banana flour ladoo had been evaluated by comparing the sample with control. The results are mentioned in table 6. Treatment 3 resulted good overall acceptability than other treatments banana ladoos.

TABLE 6
SENSORY EVALUATION OF DEVELOPED BANANA FLOUR LADOO

S. No	Criteria	Control	Treatment 1	Treatment 2	Treatment 3
1	Taste	5	6.1	6.9	7.5
2	Texture	6	6.3	6.8	7.8
3	Flavor	6.3	6.8	6.5	7.3
4	Appearance	5.5	6.4	7	7.4
5	Overall acceptability	5	6	6.7	7.3

IV. CONCLUSION

This development and quality evaluation of nutritionally enriched banana flour ladoo was to overcome the Nutrient deficiency. The banana flour ladoo was prepared by using three different treatments (T1, T2, and T3) along with control in the ratio of 50%, 60%, 70% & 100% and evaluated for protein carbohydrate, ash, moisture, color, texture profile analysis. It has protein content of 11.34 grams, carbohydrates 97.24, moisture 3.5 and ash 4%. The hardness of treatment 3 is 60 g. The treatments are packed in LDPE pouches and stored at room temperature (27°C). Sensory and microbial analyses were also conducted. Treatment – 3 was more nutritious as composition of banana flour: pearl millet: flax seed: Moringa powder: palm jaggery: (70:15:13:2:80) and desi cow ghee was more nutritious and acceptable. The cottage level processing industries may adopt this developed process technology of banana flour ladoo for income generation.

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