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Preface

We would like to present, with great pleasure, the inaugural volume-6, Issue-10, October 2020, 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.

Environmental Research:

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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Fields of Interests

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Soil Science	Plant Science
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Agricultural Chemistry	Basic biology concepts
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Natural Resources	Basic Horticulture
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Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
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Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
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Production Manager Zeal Food & Beverages Industry Aladand Road, Amandara Batkhela Malakand Agency KP. He developed the skills for Preparation of different fruit pulp preserve Orange, Peach, Guava, Strawberry, and orange squash, orange marmalade.

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In-vitro screening of indigenous botanicals of Manipur for anti fungal activities of *Helminthosporium oryzae* an incitant of brown spot disease of rice and efficacy test at different level of concentrations

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Abstract— *Eleven indigenous plant species of Manipur viz., Mariandra benghalensis, Millettia pachycarpa, Allium hookerii, Flogacanthus thyrsiflorus, Solanum incanum, Tithonia diversifolia, Goniothalamus sesquipedalis, Solanum surattense, Artemisia nilagarica, Ocimum canum and Zanthozylum acanthopodium which has been used as local medicine and spices were collected from five district of Manipur viz. Tamenglong, Senapati, Kangpokpi, Imphal east and Imphal West. In –vitro screening of above indigenous botanicals of Manipur was studied for anti-fungal activities of Helminthosporium oryzae an incitant of brown spot disease of Rice. The first five botanicals with maximum inhibition was found in Solanum incanum with 52.44% followed by Allium hookerii (47.77%), Millettia pachycarpa (36.66%), Mariandra benghalensis (24.44%) and Flogacanthus thyrsyflorus (17.77%) over control. Efficacy test at different level of concentrations i.e. 10%, 15% and 20% of standard botanical extracts was evaluated against growth of fungus both in broth and solid culture media. However, among botanicals maximum per cent inhibition on biomass production was found at 20% concentrate of S. incanum with growth inhibition of 74.03%, followed by A. hookerii (62.66%), M. Benghalensis (46.36%) and F. thyrsiflorus (42.33%) growth inhibition over the untreated control. In solid media test maximum per cent inhibition on radial growth of test fungi was found at 20% concentration in treatment of S. incanum with growth inhibition of 72.70% over control followed by A. hookerii (59.81%), M. Pachycarpa (45.03), M. benghalensis (37.59%) and F.thyrsiflorus (28.70%) over the untreated control.*

Keywords— Botanicals, Rice, Helminthosporium oryzae, Manipur.

I. INTRODUCTION

Brown spot disease of rice incited by *Helminthosporium oryzae* (Breda de Haan) is a major fungal disease of rice. The disease was known to occur in Japan since 1900 and known as nai-yake *i.e.*, seedling blight and sesame leaf spot. The disease has been reported to occur in all rice growing countries including Japan, China, Burma, Sri Lanka, Bangladesh, Iran, Africa, South America, Russia, North America, Philippines, Saudi Arabia, Australia, Malaysia and Thailand **[14, 10].**

In India the disease was first reported by Sundraman in 1919 from Madras and is known to occur in all rice growing states of India. It was found more severe in dry and direct seeded rice in the state of Bihar, Chhatisgarh, Madhya Pradesh, Orissa, Assam, Jharkhand and West Bengal **[5], [14], [17]**. Heavy infection significantly reduce the number of tillers and grains and lowered the quality and weight of individual grains resulting in a loss of 30-34% [14]. Kamal and Mia (2009) **[9]** observed yield reduction of 18.75-22.50% whereas Chakrabarti (2001) **[2]** recorded 26-52% reduction of yield due to brown spot disease incidence. Brown spot disease of rice can cause enormous losses in grain yield upto 90% particularly when leaf spotting phase assumes epiphytotic proportions as observed in Great Bengal Famine in 1942. [6]

At present indiscriminate use of the chemical compounds has causes great impact on the environmental and hazard. Therefore, plant based pesticides appears as an important alternative to synthetic chemical as they do not pose threat to natural environment, human and animal health. The present work is therefore taken up to screen for anti-fungal activity of some indigenous plants of Manipur state against *Helminthosporium oryzae* an incitant of brown spot disease of rice Many Plant extracts and botanicals have also been found to be effective against brown spot disease. **[7]** Leaf extracts of *Juglans regia* reduced mycelia growth of *Bipolaris oryzae* by 64% **[1].**

II. MATERIALS AND METHODS

Eleven indigenous plant species of Manipur *viz.*, *Mariandra benghalensis, Millettia pachycarpa, Allium hookerii, Flogacanthus thyrsiflorus, Solanum incanum, Tithonia diversifolia, Goniothalamus sesquipedalis, Solanum surattense, Artemisia nilagarica, Ocimum canum* and *Zanthozylum acanthopodium* which has been used as local medicine and spices were collected from five district of Manipur *viz*. Tamenglong, Senapati, Kangpokpi, Imphal east and Imphal West. The collected samples were botanically identified with the help of plant taxonomist from the Department of Life Sciences, Manipur University, Canchipur and Botanical Survey of India (BSI), Shillong. The collected samples were brought in the laboratory of Plant pathology, Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, for conducting the experiment.

2.1 Preparation of extracts:

Plant parts such as leaves, fruits, shoots and roots of all botanicals were washed in running tap water and finally by sterile water and air dried for one day to eliminate surface moisture **[7].** The samples were packed in envelop and kept in an oven at 60ºC temperature for drying and then grinded separately into fine powder in blender. The powdered samples were packed in plastic bags, marked and sealed in air tide and sample bottles kept in refrigerator at 4ºC for further experimental purposes.

2.2 Aqueous extracts

For making aqueous extract of all botanicals at 5%, 10%, 15% and 20% concentration methods **[15].** This was followed in which 25 g powdered plant material was dissolved in sterilized distilled water to make 100 ml of aqueous extract (25% w/v) or (25:100 w/v) and kept at room temperature for 24 hours in a sterile flask covered with aluminium foil to avoid evaporation then subjected to filtration through sterilized Whatman No.1 filter paper. After filtration, the extracts were evaporated in water bath until 25ml extracts was left in the container. The botanical extracts obtained in this form were taken as standard concentration.

2.3 Isolation of disease pathogen *Helminthosporium oryzae* and maintaining of pure culture:

Helminthosporium oryzae was isolated from infected plant parts of rice by following Motlagh and Kaviani (2008) method **[13].** The rice leaves showing characteristic symptoms of brown spot were collected from experimental paddy fields of Sam Higginbottom University of Agricultural, Technology and Sciences (SHUATS), Naini, Prayagraj, (U.P.) and brought into the laboratory. This was then cut into small pieces of 1mm slices and surface sterilized in 0.1% mercuric chloride ($HgCl_2$) for 1 minute and then rinsed with sterile water for 3 times. Three segments of these disease inoculum leaf pieces were inoculated in a petri plates containing sterilized PDA medium and incubated at 26±1ºC. After 48 hours of incubation whitish cottony growth of mycelium appeared in the petriplates. To obtain a pure culture, a tip of this mycelium was cut out with the help of sterilized inoculating needle and transfers it to a fresh sterilized PDA slants and then incubated at 26±1ºC in BOD incubator for 144 hour. The isolated pathogen culture was then observed in microscope by preparing slides and pathogen was identified following standard characterization procedures. The pathogen pure culture thus obtained were maintained in PDA slants and stored in refrigerator at 4ºC and sub cultured from time to time.

2.4 Morphological characterizations of *Helminthosporium oryzae*:

Under microscopic camera, *Helminthosporium oryzae* mycelium initially was hyaline or white cottony growth turning brown and blue black as it grow older (Photo-1). Mycelium are filamentous, cylindrical with septation and having constriction at the point of branching (Photo-2). The conidia are globule with bulged at the centre and tapering at both ends. The conidia are pale brown or yellowish in colour having 4-9 Pseudo-septation. The conidia length varied from 95.39-96.26 µm and width 18.80-27.43 µm (Photo-3). These characteristics were in accordance with that of Ou (1985) **[14]** who described that culture of *H. oryzae* was grey to olive or black in colour, conidia are 5-10 septa with slightly curved and widest at the middle. Mature conidia are sub-hyaline. Motlagh and Kaviani (2008) **[13]** also reported that conidia of *H. oryzae* isolates in India has been observed between 99-135 x 7-11 µm and 24-122x7.23 µm, usually curved, obclavate, sometime almost cylindrical, pale to mid golden brown, 5-12 distoseptate, mycelium grey to dark grey, aerial mycelium was fluffy, cottony, olivaceous with brownish tinge and septate.

PHOTO-1: Brown spot pathogen of (H. oryzae) mycelium on PDA

PHOTO-2: Microscopic view of isolated H. oryzae mycelium and conidia

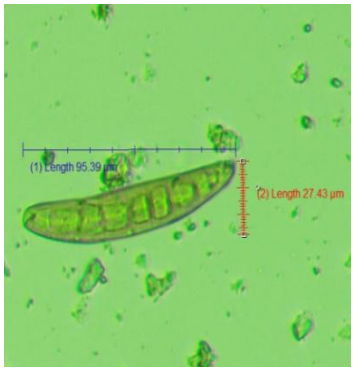


PHOTO-3: Microscopic view conidia of H. oryzae

2.5 *In-vitro* anti fungal activities test of botanicals:

2.5.1 Preliminary screening test of botanicals for anti-fungal activities

Eleven botanicals was screened following poisoned food technique of Devi and Chhetry (2013) in PDA media. **[3]** The 5% (2.5 ml) of standard botanical extracts were added to 50 ml of sterilized molten PDA then after thoroughly mixing 15 ml of the poisoned PDA was poured into sterile petri plates and allowed to solidify. Media without extracts served as control. 5 mm mycelial disc from 5 days old pathogen culture was placed at the centre of each treatment plates. Three replications were maintained for each treatment. The plates were incubated at 27±1ºC in BOD incubator. Observations was taken at 24 hours interval till fungus in the control plates covered the whole surface. Per cent inhibition of fungal growth over control was calculated by using formula, Vincent, (1947).

$$PI = \frac{C-T}{C} \times 100 \quad (1)$$

where, PI-Percent inhibition

C-Growth of fungus in control

T-Growth of fungus in treatment

Based on the preliminary screening results five best performing botanicals with maximum per cent radial growth inhibition of fungus mycelial was selected for further investigation work.

2.6 *In-vitro* studies of botanicals against biomass (dry wt. of mycelium) production of *Helminthosporium oryzae* at different level of concentration (broth medium)

The standard extract of five selected botanicals at 10%, 15% and 20% concentration were calibrated and added to the sterilized flasks containing 50 ml of potato dextrose (PD) broth media separately for each treatment concentration and gently shaken in circular motion for evenly distribution. Flasks containing media without extracts served as control and fungicide propiconazole at 1000 ppm used for comparative studies. Flasks were inoculated with 5 mm mycelium disc of 5 days old pathogen culture. For each treatment four replication were maintained. The inoculated flasks were incubated at 27±1^{o}C at BOD incubator for 10 days (240 hrs.). Flasks were shaken after every 24 hours for 1 minute. After 240 hours of inoculation mycelium mats was harvested by filtering through Whatman No.1 Filter paer (11 cm diameter), it was dried at 60ºC for 72 hours in oven and then cooled in desiccators for 24 hours then weight is taken again and data recorded. Per cent inhibition of fungal growth (biomass or dry wt. mycelium) over control was calculated by using formula given by Vincent (1947). **[18]**

2.7 *In-vitro* studies of botanicals against radial growth of *Helminthosporium oryzae* at different level of concentration (solid medium)

To study the effect of botanicals against radial growth of fungus standardized botanical extracts was calibrated at three different concentration 10%, 15% and 20% i.e. (2.5 ml, 5 ml and 7.5 ml) to 50 ml sterilized molten potato dextrose agar (PDA) medium was added separately for each concentration and gently shaken in circular motion for evenly distribution and then 15 ml of poisoned media was dispensed in sterilized 9 cm diameter petri plates and allowed to solidify. Plates containing medium without extracts served as control. Then 5 mm mycelial disc of 5 days old pathogen culture was inoculated at the

centre of the plates with mycelium mat. Four replications were taken for each treatment. The plates were incubated at 27±1ºC in BOD incubator and observations was taken at 24 hours interval till the fungus in control plates covered the whole surface of plate. Per cent inhibition of fungal growth over control was calculated by using same formula given by Vincent, 1947 **[18].**

III. RESULTS AND DISCUSSION

TABLE 1
PRELIMINARY SCREENING OF ELEVEN BOTANICALS AGAINST RADIAL GROWTH OF HELMINTHOSPORIUM ORYZAE (SOLID MEDIA)

S. No.	Treatment				Radial growth at 144hrs (cm)*	(%) growth inhibition
	Local name	Botanical name	Plant part used	(%) conc.		
1.	**T_0** Control	-	-	-	9.00	-
2.	**T_1** Nongmangkha	*Flogacanthus thyrsiflorus*	Leaves	5	7.40	17.77
3.	**T_2** Mukthrubi	*Zanthoxylum acanthopodium*	Leaves	5	7.60	15.55
4.	**T_3** Lomba	*Mariandra benghalensis*	Leaves	5	6.80	24.44
5.	**T_4** Ngamuyai	*Millettia pachycarpa*	Leaves	5	5.70	36.66
6.	**T_5** Napakpi	*Allium hookerii*	Roots	5	4.70	47.77
7.	**T_6** Lamnumitlei	*Tithonia diversifolia*	Leaves	5	7.90	12.21
8.	**T_7** Leikham	*Goniothalamus sesquipedalis*	Leaves	5	8.30	7.03
9.	**T_8** Khamenkha	*Solanum incanum*	Fruits	5	4.28	52.44
10.	**T_9** Laibakngou	*Artemisia nilagarica*	Leaves	5	8.70	3.30
11.	**T_{10}** Leipungkhang	*Solanum surattense*	Leaves	5	7.60	15.55
12.	**T_{11}** Mayangton	*Ocimum canum*	Leaves	5	7.50	16.66
13.	**T_{12}** Propiconazole	-	-	1000 ppm	1.02	88.66
	S. Ed (±)	-	-	-	**0.40**	**4.51**
	CD (0.05%)	-	-	-	**0.92**	**10.19**

Mean value of three replication

The data presented in Table 1 is the preliminary screening results of botanicals extracts against the radial growth of *Helminthosporium oryzae.* The results found that out of eleven botanicals screened 9 were found significantly reducing the radial growth of *H. oryzae* as compared with the untreated control. Among the botanicals maximum significant reduction on radial growth was recorded in T_8-*Solanum incanum* (4.28 cm) followed by T_5-*Allium hookerii* (4.7 cm), T_4-*Millettia pachycarpa* (5.7) cm, T_3-*Mariandra benghalensis* (6.8cm),T_1-*Flogacanthus thyrsiflorus* (7.4 cm), T_{11}-*Ocimum canum* (7.5 cm), T_2-*Zanthoxylum acanthopodium* (7.6 cm), T_{10}-*Solanum surattense* (7.6 cm),T_6-*Tithonia diversifolia* (7.9 cm). However, treatment T_9-*Artemisia nilagarica* (8.7 m) and T_7-*Gonothalamus sesquipedalis* (8.3 cm) were found not significant as compared with untreated T_0-control (9 cm).

TABLE 2

***IN-VITRO* BIOMASS PRODUCTION OF *HELMINTHOSPORIUM ORYZAE* AS AFFECTED BY BOTANICALS AT DIFFERENT CONCENTRATION**

S. No.	Treatment	Biomass (mycelium dry wt.) of *H. oryzae* (g)				% growth inhibition over control			
		Concentrations				Concentrations			
		10%*	15%*	20%*	Mean**	10%	15%	20%	Mean**
1.	T_0 Control	0.33	0.33	0.33	**0.33**	-	-	-	-
2.	T_1 *Mariandra benghalensis*	0.26	0.22	0.17	**0.21**	21.21	33.33	48.48	**34.34**
3.	*T2 Millettia pachycarpa*	0.24	0.21	0.15	**0.20**	27.27	36.36	54.54	**39.39**
4.	T_3 *Allium hookerii*	0.18	0.19	0.12	**0.16**	45.45	46.39	42.33	**44.72**
5.	T_4 *Flogacanthus thyrsiflorus*	0.28	0.24	0.19	**0.23**	15.15	27.27	42.42	**28.28**
6.	T_5 *Solanum incanum*	0.17	0.14	0.10	**0.13**	48.48	57.57	69.69	**58.58**
7.	T_6 *Propiconazole*	0.05	0.05	0.05	**0.05**	84.84	84.84	84.84	**84.84**
	Mean* **	**0.22**	**0.19**	**0.14**		**50.48**	**62.42**	**58.51**	-
	S Ed9±1	**0.01**	**0.01**	**0.006**	-	**4.50**	**6.31**	**1.59**	-
	CD	**0.04**	**0.05**	**0.018**	-	**13.50**	**18.00**	**4.78**	-

Mean value of four replication

****Mean irrespective of concentration***

*****Mean irrespective of treatment***

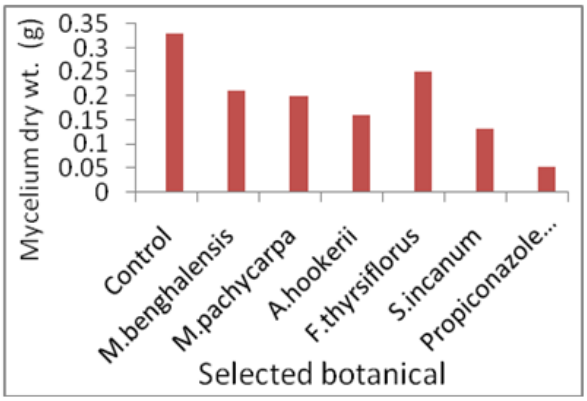


FIGURE 1: Botanicals against biomass production of *H. oryzae*

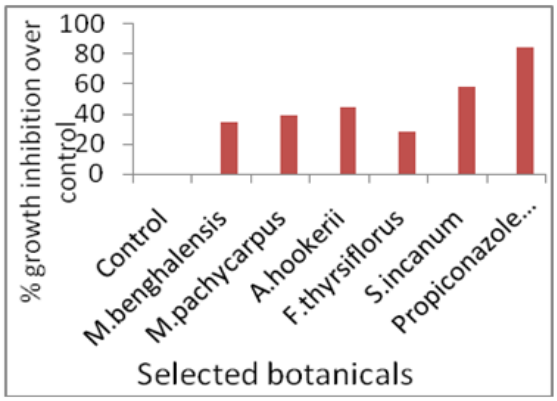


FIGURE 2: Botanicals and per cent inhibition of *H. oryzae* over control

Data presented in Table 2 and Fig.1 & 2 shows the effect of botanicals at different concentration on fungal biomass (dry wt. mycelium) production of *Helminthosporium oryzae*.

At 10% concentration, **a**ll selected five botanicals *viz.* T_5-*Solanum incanum*, T_3-*Allium hookerii*, T_2-*Millettia pachycarpa*, T_1-*Mariandra benghalensis* and T_4-*Flogacanthus thyrsiflorus* significantly inhibit the fungal biomass (dry wt. mycelium) production of *Helminthosporium oryzae*. Maximum reduction on biomass production was recorded in T_5-*Solanum incanum* (0.17 g) with per cent reduction (58.58%) over control, followed by T_3-*Allium hookerii* (0.18 g) growth reduction(44.72%), T_2-*Millettia pachycarpa* (0.24 g)growth reduction (39.39%), T_1-*Mariandra benghalensis* (0.26 g)growth reduction (34.43%) and least significant effect was found in T_4-*Flogacanthus thyrsiflorus* (0.28 g) growth reduction (15.15%), over the control T_0(0.33 g).

At 15% concentration, all botanicals significantly inhibit biomass (dry wt. mycelium) production as compared with control. Among the treatments maximum significant reduction on fungal biomass production was recorded in T_5-*S. incanum* (0.14g) with per cent growth reduction of (86.87), followed by T_3-*A. hookerii* (0.19g) and per cent growth reduction (69.11), T_2-*M. pachycarpa* (0.21g) growth reduction (62.82%), T_1-*M. benghalensis* (0.22g) growth reduction(57.30%) and T_4-*Flogacanthus thyrsiflorus* (0.24g) growth reduction (46.39%) over untreated control.

At 20% concentration, all treatments significantly inhibit biomass production. Among botanicals maximum significant reduction was recorded in T_5-*S. incanum* (0.10 g) with per cent growth reduction (74.03) followed by T_3-*A. hookerii* (0.12 g) growth reduction(62.66%), T_2-*M. pachycarpa* (0.15 g) growth reduction(51.16%), T_1-*M. benghalensis* (0.17 g) growth reduction (46.36%) and T_4-*F. thyrsiflorus* (0.19 g) growth reduction (42.33%) over the untreated T_0-control (0.27 g). Propiconazole use as check recorded (0.04 g) with per cent reduction of (85.18) over the untreated control.

TABLE 3

***IN-VITRO* RADIAL GROWTH OF *HELMINTHOSPORIUM ORYZAE* AS AFFECTED BY BOTANICALS AT DIFFERENT CONCENTRATION**

Sl. No.	Treatment	Average radial growth *H. oryzae* mycelium (cm)				% growth inhibition over control			
		Concentrations				Concentrations			
		10% *	15% *	20% *	Mean**	10%	15%	20%	Mean**
1.	T_0 (Control)	9.00	9.00	9.00	9.00	-	-	-	-
2.	T_1 (*M. benghalensis*)	7.19	7.03	6.94	7.05	20.11	21.88	22.88	21.36
3.	T_2 (*M. pachycarpa*)	6.09	6.03	6.01	6.04	32.32	33.00	33.22	32.84
4.	T_3 (*A. hookerii*)	5.09	5.01	4.94	5.01	43.44	44.33	45.11	44.29
5.	T_4 (*F. thyrsyflorus*)	7.79	7.73	7.64	7.72	13.44	14.11	15.11	14.22
6.	T_5 (*S. incanum*)	4.67	4.16	3.78	4.20	48.11	53.77	58.00	33.29
7.	T_6 (Propiconazole)	1.41	1.45	1.46	1.44	84.33	83.88	83.77	83.99
	Mean***	5.58	5.27	5.17	-	41.28	42.37	42.87	-
	S. Ed (±)	**0.18**	**0.25**	**0.30**	**-**	**0.57**	**4.10**	**2.53**	**-**
	CD (0.05%)	**0.39**	**0.53**	**0.64**	**-**	**1.21**	**8.80**	**7.59**	**-**

Mean value of four replication

***** Mean radial growth of mycelium irrespective of concentration***

*******Mean radial growth of Mycelium irrespective of treatment***

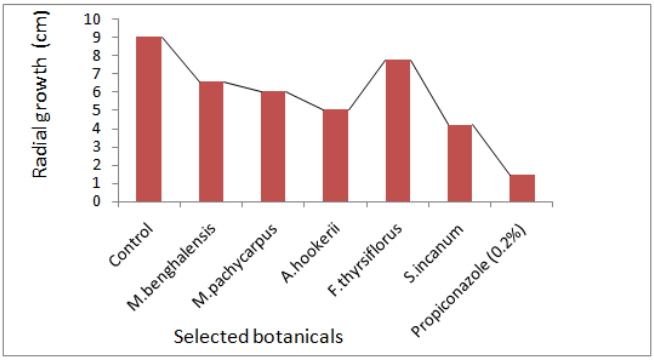


FIGURE 3: Botanicals on radial growth *H. oryzae* at144 hrs irrespective of conc.

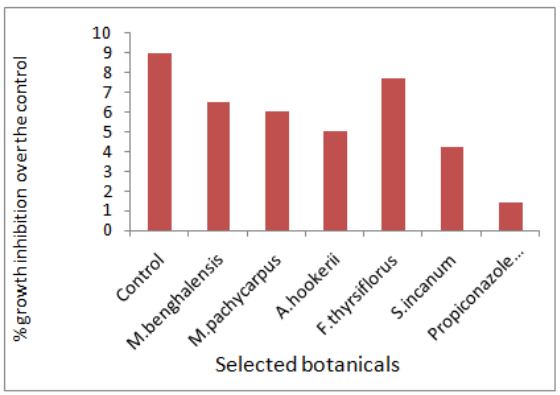


FIGURE 4: Botanicals and percent inhibition of *H. oryzae* over control

The results data presented on Table 3 and Fig. 3 & 4 shows the effect of various botanicals at different concentration on radial growth of *Helminthosporium oryzae.*

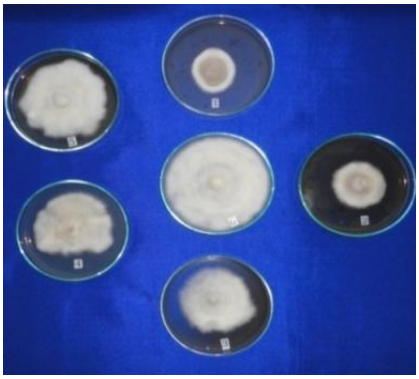
At 10% concentration, all botanicals were found statistically significant in reducing the radial growth of *H. oryzae*. Among the treatments maximum reduction on radial growth of mycelium was found in T_5-*Solanum incanum* (4.67 cm) with per cent inhibition (53.65) over control, followed by T_3-*Allium hookerii* (5.09 cm) growth inhibition (48.98%), T_2-*Millettia pachycarpa* (6.09 cm)growth inhibition (37.87%), T_1-*Mariandra benghalensis* (7.19 cm) growth inhibition (25.65%) and least significant reduction was found in T_4-*Flogacanthus thyrsiflorus* (7.79 cm) with growth inhibition of(18.98%) in compared with T_0-control (9.39 cm).

At 15% concentration, all botanical extracts were found statistically significant in reducing the radial growth of fungus over untreated control. Among the treatments maximum significant reduction of mean radial growth was observed in T_5-*S. incanum* (4.16 cm) with per cent growth inhibition (68.46) over control, followed by T_3-*A. hookerii* (5.13 cm) growth inhibition (57.68%), T_2-*M. pachycarpa* (6.23 cm) growth inhibition (45.66%), T_1-*M. benghalensis* (7.03 cm)growth inhibition(36.57%) and T_4-*F. thyrsiflorus* (7.73 cm) growth inhibition (28.79) in compared to T_0-Control (9.0 cm).

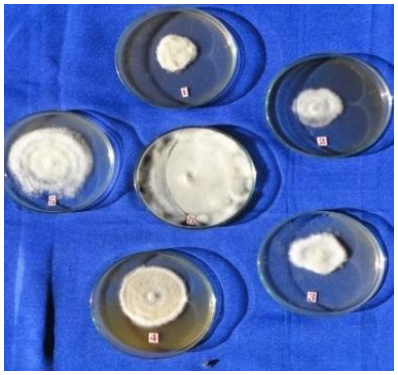
At 20% concentration all treatments found significantly reduced radial growth of fungus over control. Among the botanicals maximum radial growth inhibition was recorded in T_5-*S. incanum* (3.78 cm) with per cent inhibition (72.70) followed by T_3-*A. hookerii* (4.94 cm) growth inhibition (59.81%), T_2-*M. pachycarpa* (6.14 cm) growth inhibition (45.03%), T_1-*M. benghalensis* (6.94 cm) growth inhibition(37.59%) and minimum effect was observed in T_4-*F. thyrsiflorus* (7.74 cm) growth inhibition (28.70%) in compared to with untreated T_0-control (9.64 cm).

The results revealed that effectiveness on radial growth inhibition increases with the increase in dose per cent concentration and found maximum at highest dose of 20% conc.(5.17 cm) followed by 15% conc. (5.21 cm) and 10% conc. (5.58 cm) with per cent reduction of 42.87, 42.31 and 41.28 respectively over control.

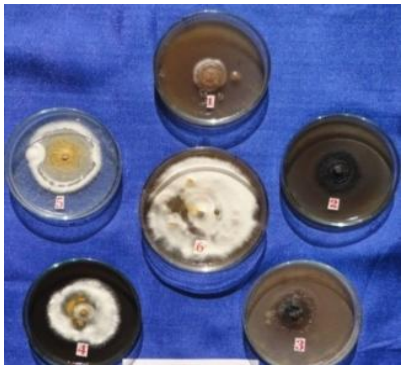
It is evident from the above results that all botanicals significantly suppressed biomass and radial growth of *H. oryzae*. However, highest efficacy among selected five botanicals was observed in *Solanum incanum* fruits extracts and root extracts of *Allium hookerii.* The studies also found that all botanicals extracts increased its efficacy with per cent increase in treatment's concentration. (Table.4) Our present finding was in agreement with that of Gaichui (2008) **[4]** during *in-vitro* study on bio-efficacy of different indigenous plant of Manipur against *fusarium wilt* of chilly reported that Darrek (*Malea azadirach*) can best inhibit the growth of fungus in all the three concentration at 5%, 10%, and 15%, however the best results was recorded in the higher dose concentration of 15% with fungal growth inhibition of 93.71% over the untreated control. Devi and Chhetry (2013) **[3]** during *in-vitro* test on anti fungal activities of certain indigenous plant extracts of Manipur found that *Acorus calamus* 20% concentration can inhibit mycelium growth of *Drechlera oryzae* a brown spot disease of rice pathogen upto 80%. They also found that other plants extracts such as *Artemisia vulgaris* and *Centelia asiatica* extracts 20% can inhibit growth of fungus upto 40%. Methanolic extracts of medicinal plants viz. *Bergia capensis, Marselia quadrifolia, Lippiano diflora, Eclipta prostrate* and *Commelina clavata* (Manimegalai *et al.*, 2011) an essential plant oils from basil (*Ocimum basilicum*) and sweet fennel (*Ocimum gratissimum*) showed good inhibitory activity against *Bipolaris oryzae* **[12].** Neem oils 3% and leaf extracts 3% can inhibit growth of *Bipolaris oryzae* upto (54.25%) and (49.74%) respectively in food poison technique *in-vitro* test **[8].**



[A] Fungal growth at 10% conc.



[B] Fungal growth at 15 % conc.



[C] Fungal growth at 20 % conc.

[Pt-1.*S. incanum*, Pt-2. *Allium hookarii*, Pt-3.*M. pahycarpus*, Pt-4.*M. Benghalensis*, Pt-5.*F. Thyrsiflorus*, Pt-6. Control]

TABLE 4
LIST OF ELEVEN INDIGENOUS BOTANICALS OF MANIPUR AND ITS MEDICINAL VALUE AND SECONDARY METABOLITES COMPOUND DETECTED USED IN STUDY

S. No.	Local name	Scientific name	Part used in analysis	Collection location and district	Economic utility	Detected secondary metabolites compound
1.	Lomba	*Mariandra benghalensis*	leaves	Siangai, Senapati	leaves and inflorescence were use as spice and for treatment of sore throat and dry cough	tannin, caumarin, glycoside
2.	Ngamuyai	*Millettia pachycarpus*	leaves	Siangai, Senapati	leaves were use for fish poisoning and treatment of scabies	phenolic, alkaloid, flavanoid, caumarin, saponin, glycoside
3.	Napakpi	*Allium hookerii*	roots	Porompat, Imphal East	whole plant is use as spice and for treatment of hypertension	terpinoid, saponin
4.	Nongmangkha	*Flogacanthus thyrsiflorus*	leaves	Langol, Imphal west	leave and inflorescence decoction for treatment of high blood pressure, steam inhalation for relief of runny nose, sore throat, cold and cough	phenolic, tannin, terpinoid, glycoside, saponin,
5.	Khamenkha	*Solanum incanum*	fruits	Longmai, Tamenglong	treatment for stomach ulcer, pile case	phenolic, tannin, caumarin, saponin, terpinoid, glycoside
6.	Lamnumitlei	*Tithonia diversifolia*	leaves	Changoubung, Kangpokpi	leaves extracts is treated for skin allergy	saponin
7.	Laikham	*Ganiothalamus sesqui*	leaves	Hengbung, Senapati	dry leaves burning is act as insect repellent, ash is used for treatment of stomach acidity and relief of stomach-aches	flavanoid, caumarin, glycoside
8.	Leipungkhanga	*Solanum surattense*	leaves	Porompat, Imphal East	use for treatment of toothache, and stomach ulcer	phenolic, saponin, terpinoid, glycoside
9.	Laibak-ngou	*Artemisia nilagarica*	leaves	Maram, Senapati	used in treatment of wound and arresting of bleeding	tannin, alkaloid, terpinoid
10.	Mayangton	*Ocimum canum*	leaves	Nungang, Senapati	use as spice, treatment of sore throat, and cough	phenolic, alkaloid, flavanoid, terpinoid
11.	Mukthrubi	*Zanthozylum acanthopodia*	leaves	Siangai, Senapati	Use as spice, use in treatment of mouth ulcer and fruits is used for treatment of toothache	phenolic, alkaloids, flavanoid, saponin

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Study on Ground Water of Various Locations in Dewas Industrial Area of Madhya Pradesh India

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Abstract— *This study on the ground water quality status of various locations in Dewas industrial area of Madhya Pradesh India. Study of physico-chemical parameters of ground water was carried out during different four quarters from April 2019 to March 2020. Nine monitoring locations in Dewas industrial area were selected for this study. Ground water monitoring was performed as per standard guidelines followed by Central Pollution Control Board and analyzed by standard methods. It is concluded that high contamination w.r.t. total dissolved solids, chlorides, fluorides, nitrate, sulphate etc. in ground water observed at few locations in Dewas industrial area during this study and water quality if compare with drinking water standard BIS, 10500 (2012). The ground water quality does not meet the standard. The deterioration of ground water quality may be due to impact of industrial activities.*

Keywords— Industrial Area, Ground Water, Water Pollutants, Water Quality.

I. INTRODUCTION

The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use (public water supply, irrigation, industrial application, power generation etc). The quality of ground water is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors. Generally higher proportion of dissolved constituent is found in ground water than in surface water because of greater interaction of ground water with various materials in geologic strata. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems [1].

The major source of water pollution is domestic waste from urban and rural areas and industrial waste which is discharge into natural water bodies. Chemical industries also have concern with in respect of disposal hazardous waste [2].Discharged from industries contains a number of chemical pollutions, such a Ammonia, Arsenic, Phenol, Cyanide, Thiocynide, Copper, Cadmium, Zinc, Chromium, Carbonate, Bi-carbonate, Nitrite, Phosphate, Oil and Grease in addition to total suspended solids volatile solids and score of other toxicants. It is difficult to imagine production human activity, be it agriculture or forestry, Livestock, farming & fisheries, trade or industry. The chemical, physical and bacterial characteristics of ground water determined. These pollutants could bring about changed in temperature, humidity, oxygen supply, pesticide stress etc. amounting to a partial or complete alteration in the physical, chemical and physiological spheres of the biota [3].The physical and chemical properties of the substances influence their behavior in the subsurface and their likely impact on groundwater quality [4]. Partially treated industrial effluents combined with sewage and other wastes discharged on the surface cause severe groundwater pollution in the industrial belt [5].

In modern industrialization period, the most of water resources have affected enormously by seepage, leaching and mixing of industrial effluents in most of the metropolitan cities and industrial townships [6]. The industrial effluents contain toxic chemicals, hazardous compounds, suspended solids and nonbiodegradable materials. The major source of surface and ground water pollution is injudicious discharge of untreated industrial effluents directly into the surface water bodies resulting in surface and ground water pollution [7].

The industrial effluents if not treated properly controlled, can pollute and cause serious damage to the ground water resources [8]. Since, groundwater is occupying a major portion of water supply for both domestic and industrial purposes nowadays, it

is highly essential that, its quality should match the domestic water standards [9]. Though industrial use of water is very low as compared to agricultural use, the disposal of industrial effluents on land and/or on surface water bodies make water (ground and surface) resources unsuitable for other uses. Industry is a small user of water in terms of quantity, but has a significant impact on quality [10]. Ground water pollution is intrinsically difficult to detect, since the problem may well be concealed below the surface and monitoring is costly, time consuming and hard to resolve [11]. The most common and widespread health risk associated with drinking water is microbial contamination which has the potential to cause large outbreaks of water born diseases like dysentery, cholera, typhoid, skin infections etc [12]. Therefore ground water quality, especially in areas that immediately surround industrial area are of increasing interest for study. This paper is an important study on the ground water quality status of various locations in Dewas industrial area of Madhya Pradesh India.

II. METHODOLOGY

2.1 Study Area

Dewas District in Ujjain Revenue Division, is situated on the Malwa plateau in the West-central part of Madhya Pradesh, India and lies between 20°17´ and 23°20´ North latitude and 75°54´ and 77°08´ East longitude. The district is bounded by Ujjain district in the north, Indore district in the west, West-Nimar district in the south-west, East Nimar district in the south, Hoshangabad district in the South East, Sehore district in the east and Shajapur district in the North-East.

2.2 Monitoring Locations

Dewas industrial area is consist of four industrial area i.e. Industrial Area 1 , Industrial Area 2 & 3, Sia Industrial Area, Ujjain Road Industrial Area. Total nine locations in different industrial area in Dewas were selected for ground water monitoring is depicted in table 1 and figure 1.

TABLE 1
MONITORING LOCATIONS

S.N	Code	Industrial Area	Monitoring Locations	Latitude & Longitude	Ground water Source
1.	W1	Industrial Area 1	M/S White star milk and milk products , Dewas	22.5754 & 76.2453	**Borewell**
2.	W2	Industrial Area 1	M/S Tata International Ltd, Dewas	23.1064 & 77.52432	**Borewell**
3.	W3	Industrial Area 1	M/S Raj Pioneer Laboratories (India), Dewas	23.07689 & 77.55652	**Borewell**
4.	W4	Industrial Area 2 & 3	M/S Roca Bathroom Products Pvt Ltd (Parryware Industry) Dewas	23.11448 & 77.51583	**Borewell**
5.	W5	Industrial Area 2 & 3	M/S VE Commercial Vehicle Ltd unit 2 (Eicher), Dewas	23.10886 & 77.51757	**Borewell**
6.	W6	Industrial Area 2 & 3	M/S Navin Fluorine International Ltd, Dewas	23.09844 & 77.52922	**Borewell**
7.	W7	Sia Industrial Area	M/S Krishna Food Products Ltd, Dewas	23.08073 & 77.53493	**Borewell**
8.	W8	Ujjain Road Industrial Area	M/S Kriloskar Brother's Ltd, Dewas	23.07719 & 77.54176	**Borewell**
9.	W9	Ujjain Road Industrial Area	M/S Bank Note Press , Dewas	23.07449 & 77.53204	**Borewell**

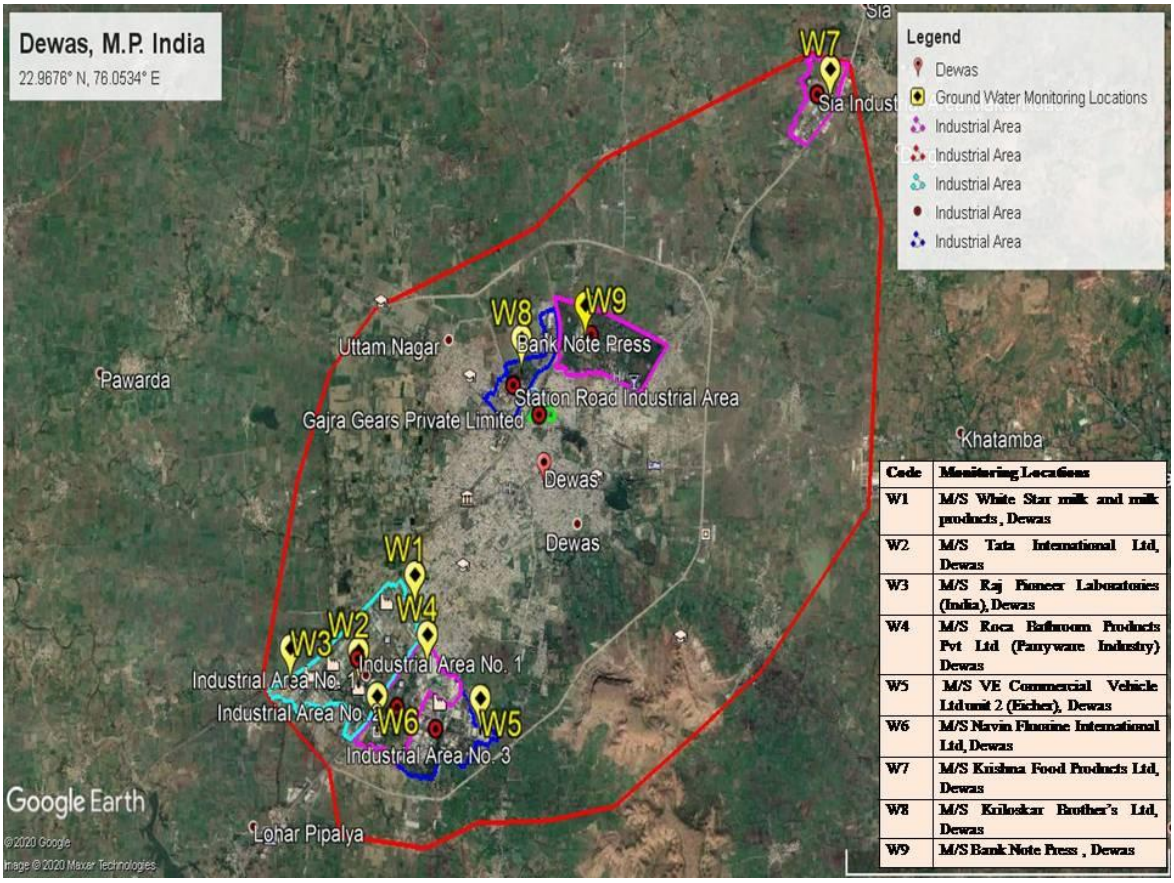

FIGURE 1: Monitoring Locations around Dewas industrial area

2.3 Monitoring and Analysis

All ground water monitoring was done as per standard guidelines followed by Central Pollution Control Board [13]. Water samples were drawn from bore wells and samples were analyzed by as per standard methods [14] during this study. All results were compared with standard limits prescribed of drinking water of BIS 10500 (2012) [15].

III. RESULT & DISCUSSION

The study of ground water quality data is depicted in table 2 and figure 2 to 13.

In figure 2, the pH ranges from 7.05 (W8) -7.36 (W2, W7) which was within the limits of BIS: 10500 (6.5-8.5) at all monitoring locations during this study.

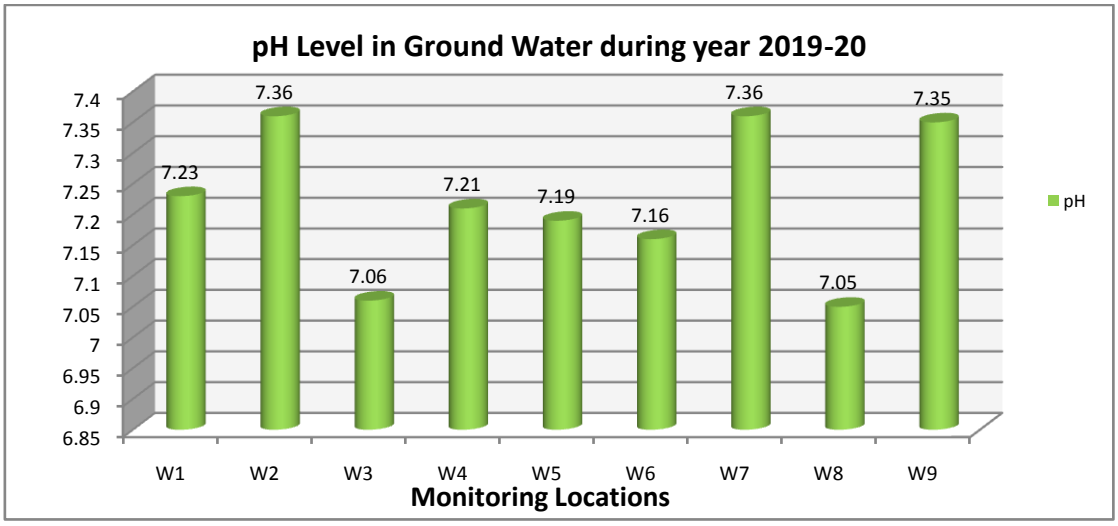

FIGURE 2: pH level of ground water

TABLE 2
PHYSICOCHEMICAL STUDY OF GROUND WATER OF DEWAS INDUSTRIAL AREA

S. N.	Analytes	Unit	BIS, 10500 (2012)		W1	W2	W3	W4	W5	W6	W7	W8	W9
			Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source									
1	Colour	Hazen unit	5	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	pH	pH unit	6.5-8.5	Not Relaxation	7.23	7.36	7.06	7.21	7.19	7.16	7.36	7.05	7.35
3	Turbidity	NTU	1	5	0.9	3.68	3.30	4.4	3.5	4.6	0.33	0.23	0.5
4	Total Dissolved Solids	mg/l	500	2000	889	1742	2106	1582	889	1621	1079	1268	635
5	Chloride	mg/l	250	1000	197	594	778	474	173	307	346	325	139
6	Ammonical Nitrogen	mg/l	0.5	Not Relaxation	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7	Nitrate	mg/l	45	Not Relaxation	82.3	33.79	70.61	39.8	50.1	61	26.07	59.8	11
8	Total Alkalinity	mg/l	200	600	285	142	247	261	243	427	203	260	254
9	Total Hardness	mg/l	200	600	660	730	1403	948	573	1160	565	670	201
10	Sulphate	mg/l	200	400	289	428	545	720	275	590	481	284	151
11	Fluoride	mg/l	1	1.5	1.22	0.81	1.09	1.1	1.2	1.64	1.07	0.81	1
12	Calcium ion	mg/l	75	200	117	196	245	220	128	221	147	204	37
13	Magnesium ion	mg/l	30	100	82	59	193	97	62	148	48	39	27
14	Mn	mg/l	0.3	0.1	0.082	0.051	0.058	0.070	0.108	0.307	0.026	0.028	0.013
15	Cu	mg/l	0.05	1.5	0.206	0.329	0.166	0.082	0.247	0.11	0.021	0.016	0.015
16	Zn	mg/l	5	15	0.373	0.414	0.299	0.082	0.413	0.107	0.048	0.212	0.127
17	Fe	mg/l	0.3	Not Relaxation	0.590	3.309	0.584	0.695	0.391	0.595	0.165	0.050	0.090
18	Cd	mg/l	0.003	Not Relaxation	0.019	0.023	0.023	BDL	0.017	0.016	0.020	0.014	0.011
19	Ni	mg/l	0.02	Not Relaxation	0.105	0.271	0.114	0.105	0.094	0.105	0.092	0.103	0.112
20	Pb	mg/l	0.01	Not Relaxation	0.152	0.153	0.168	0.316	0.149	0.147	0.077	0.102	0.062

In Figure 3, Turbidity was found in the range of 0.23 (W8) – 4.6 (W6) NTU during this study.

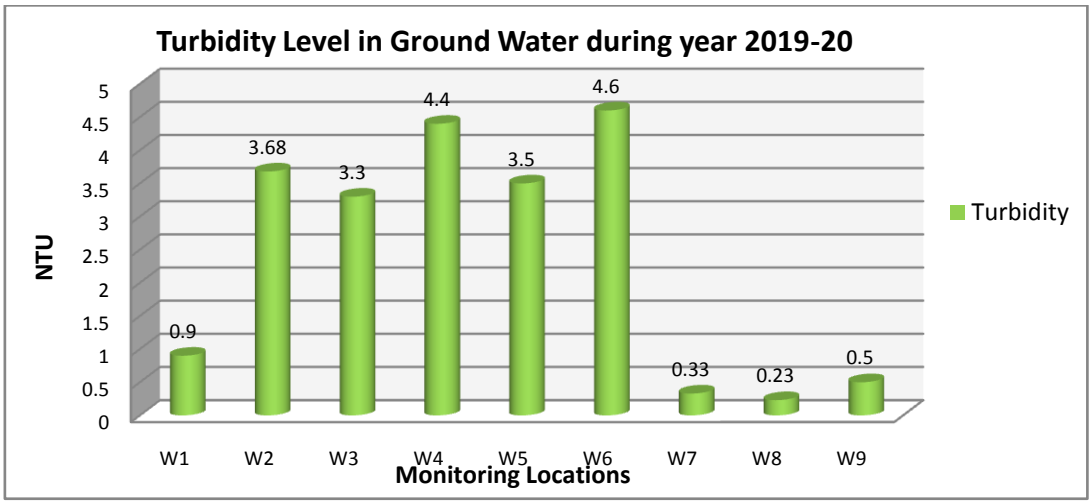

FIGURE 3: Turbidity level of ground water

In Figure 4, total dissolved solids was found in the range of 635 (W9) – 2106 (W3) mg/l during this study.

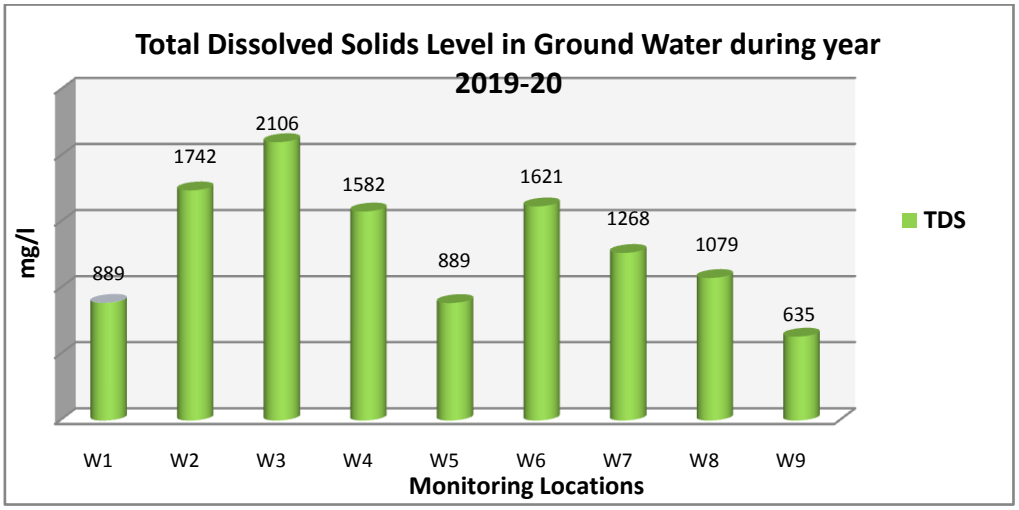

FIGURE 4: TDS level of ground water

Figure 5 is showing that minimum average concentration of total alkalinity was found 142 mg/l (W2) and maximum concentration 427 mg/l (W6) during this study.

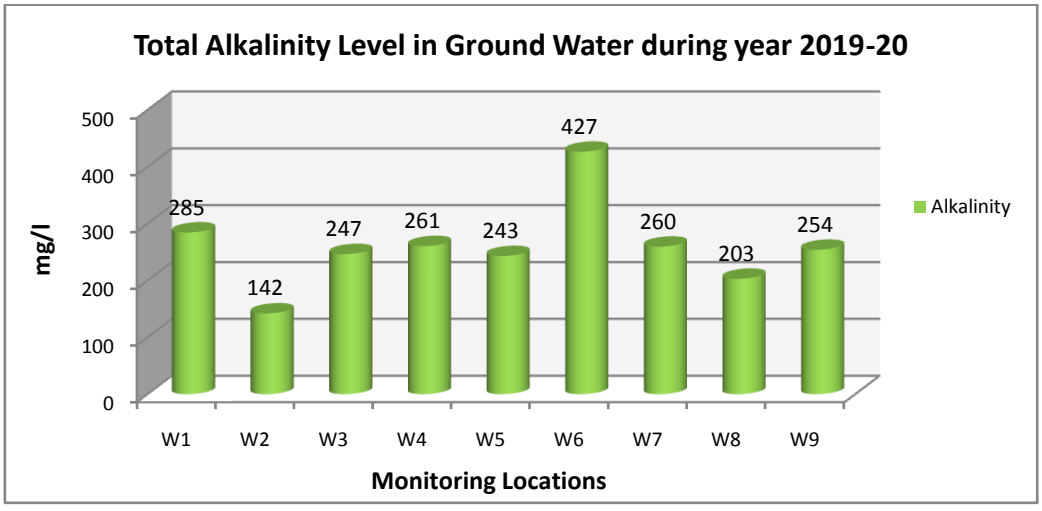

FIGURE 5: Total alkalinity level of ground water

Figure 6 is showing that minimum average concentration of chloride was found 139 mg/l (W9) and maximum concentration 778 mg/l (W3) during this study.

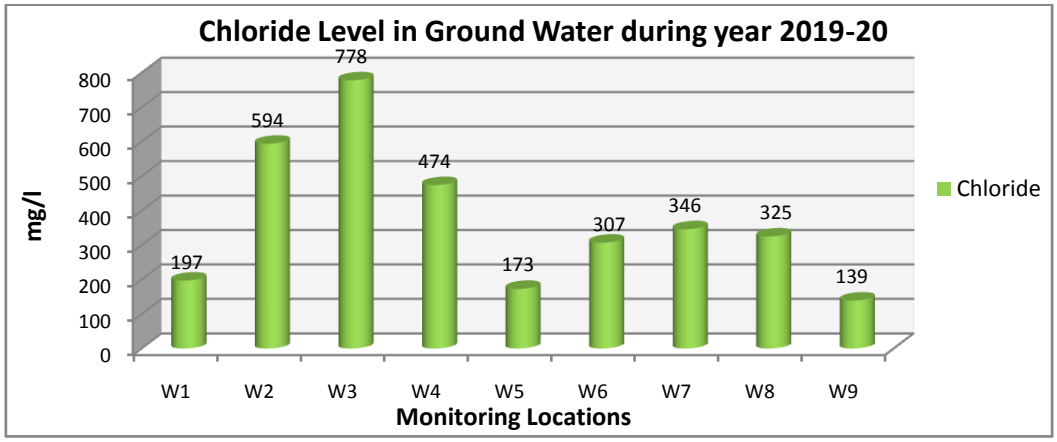

FIGURE 6: Chloride level of ground water

Ammonical nitrogen was not detected in ground water at all monitoring locations during this study. Figure 7 is showing that minimum average concentration of fluoride was found 0.81 mg/l (W2, W8) and maximum concentration 1.64 mg/l (W6) during this study.

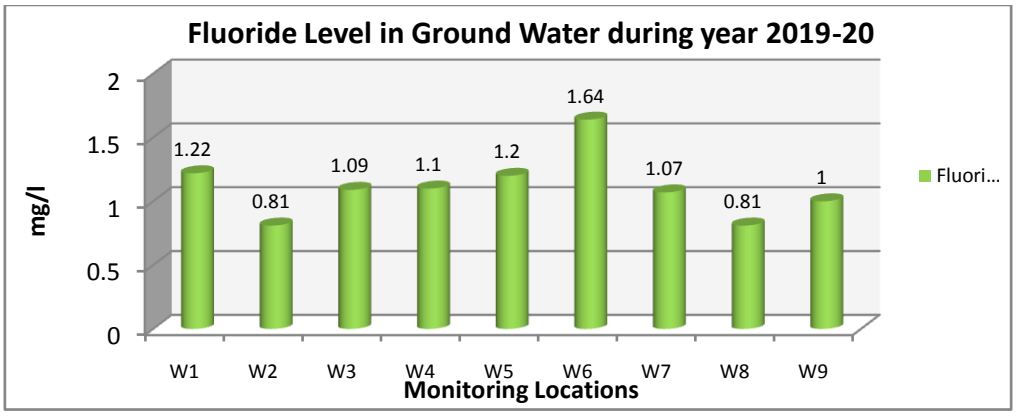

FIGURE 7: Fluoride level of ground water

Figure 8 is showing that minimum average concentration of nitrate was found 11 mg/l (W9) and maximum concentration 82.3 mg/l (W1) during this study. The presence of little higher concentration of nitrate in water is an indication of pollution in ground water may cause eutrophication as a nutrient, hence reducing water quality.

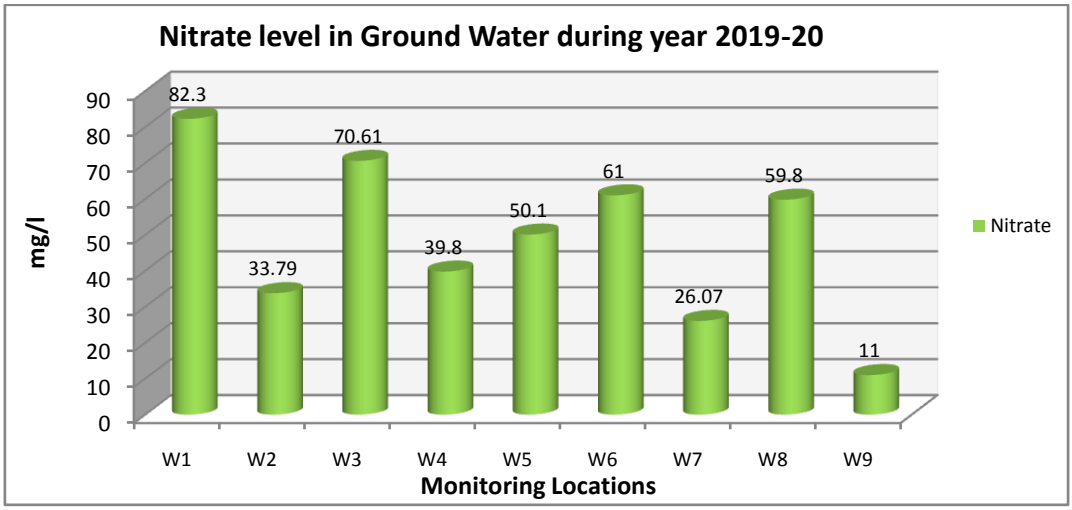

FIGURE 8: Nitrate level of ground water

Figure 9 is showing that minimum average concentration of total hardness was found 201 mg/l (W9) and maximum concentration 1403 mg/l (W3) during this study.

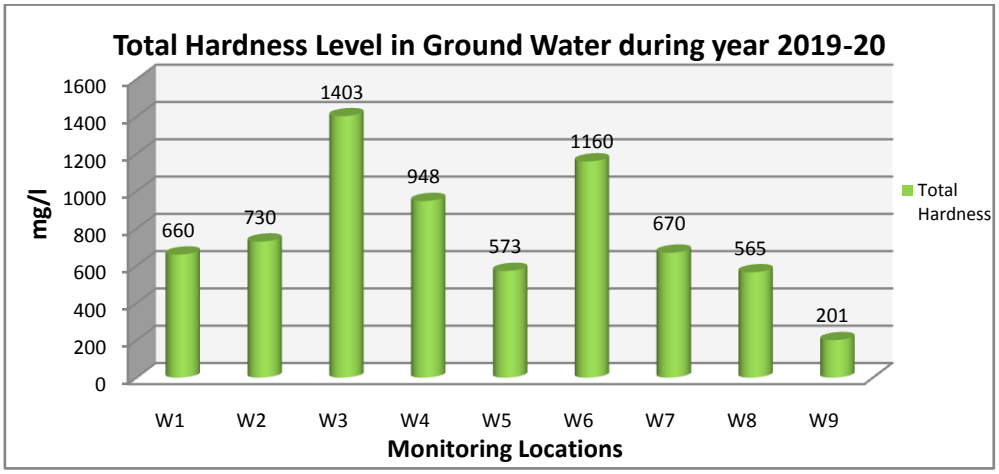

FIGURE 9: Total Hardness level of ground water

Figure 10 is showing that minimum average concentration of sulphate was found 151 mg/l (W9) and maximum concentration 720 mg/l (W4) during this study.

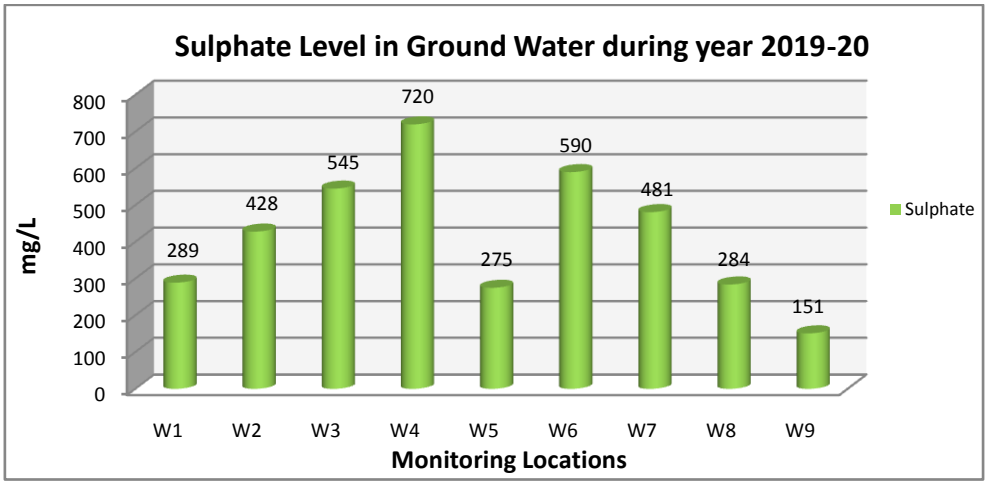

FIGURE 10: Sulphate level of ground water

Figure 11 is showing that minimum average concentration of calcium ion was found 37 (W9) and maximum concentration 245 (W3) during this study.

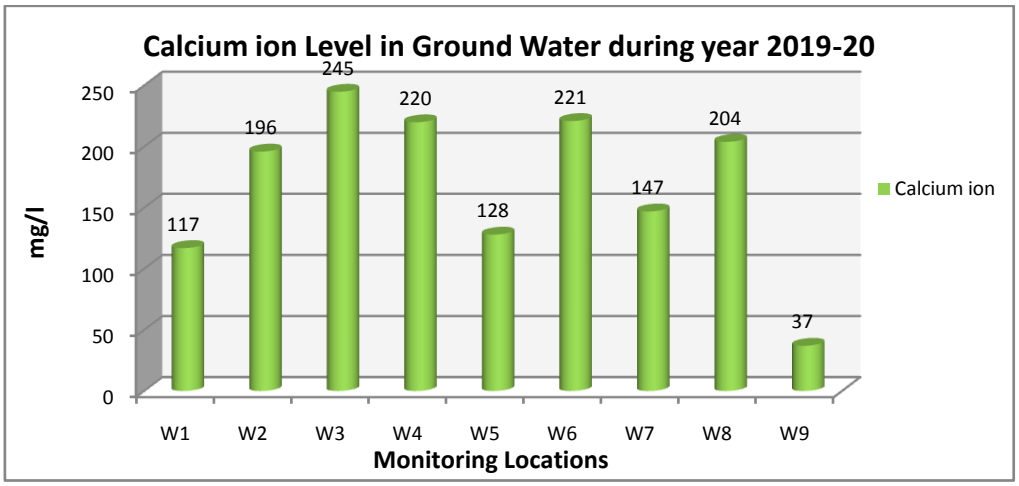

FIGURE 11: Calcium ion level of ground water

Figure 12, is showing that minimum average concentration of magnesium ion was found 27 (W9) and maximum concentration 193 (W3) during this study.

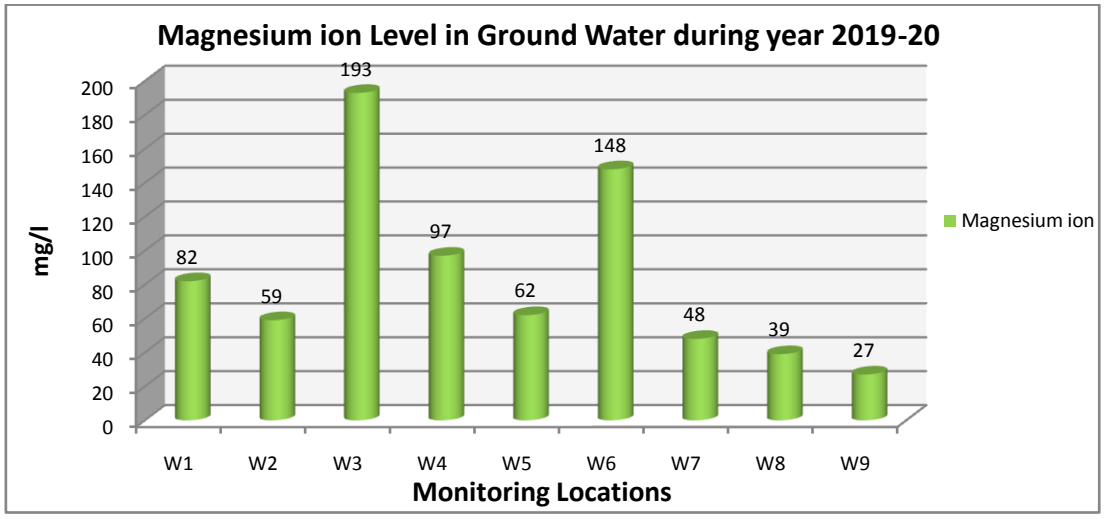

FIGURE 12: Magnesium ion level of ground water

In Figure 13, Observed order of the analyzed heavy metals were found Fe> Mn>Zn >Cu during this study.

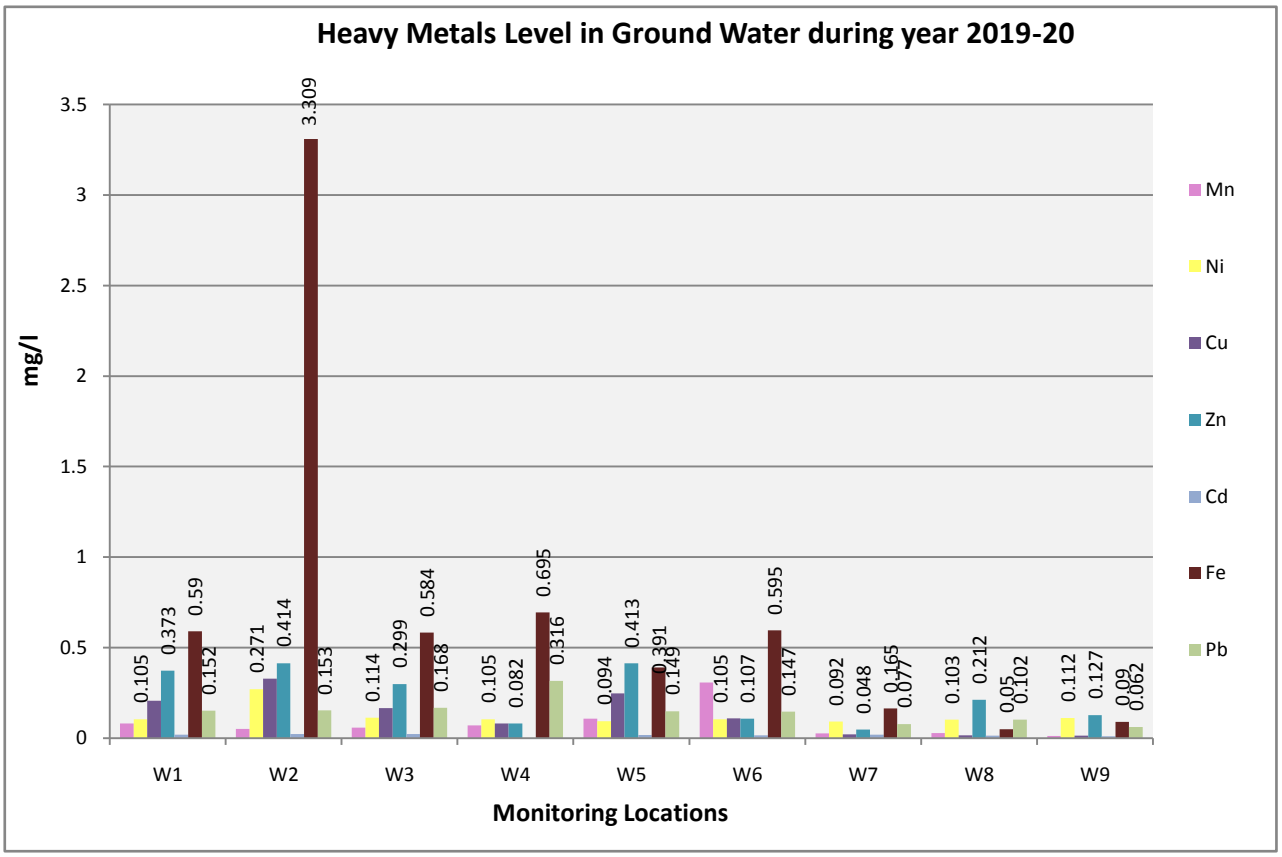

FIGURE 13: Heavy metals level of ground water

IV. CONCLUSION

It is concluded that high contamination in ground water observed at few locations around Dewas Industrial area during this study as compare with drinking water standard BIS, 10500 (2012). The ground water quality does not meet the standard. The deterioration of ground water quality may be due to impact of industrial activities. All activities, which carried out on the ground surface have direct or indirect impact on the groundwater whether associated with urban , industrial or agricultural activities large scale concentrated source of pollutants such as industrial discharge, subsurface injection of chemicals and

hazardous are obvious source of ground water pollutants. May deepness of water source, sewage source, anthropogenic, industrial activities and other sources are reason of presence of trace amount of pollutant in ground water of Dewas industrial area.

ACKNOWLEDGEMENTS

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Effects of Different Levels of Seaweed (*Eucheuma spinosum*) on the Sensory Qualities and Selling Price of Fish Balls

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Abstract— *The study aimed to determine the sensory qualities and selling price of fish balls with the different levels of seaweed (Eucheuma spinosum). Five treatments were applied in this study; Control (0 seaweed), T_1 (25% seaweed), T_2 (50% seaweed), T_3 (75% seaweed), and T_4 (100% seaweed). Experimental samples were laid out using a completely Randomized Design (CRD). Different samples were subjected to sensory evaluation and selling price determination. Results were analyzed using ANOVA and DMRT when treatments were found to be significantly different from each other. Results revealed that different combinations of fish and seaweeds significantly affected the sensory qualities of fish balls in terms of color, aroma, flavor, texture and general acceptability. The treatment with the least amount of seaweed added showed the highest sensory score in all the sensory parameters.*

Keywords— Seaweed processing, fish balls, sensory evaluation, consumer acceptability.

I. INTRODUCTION

Figures from FAO (2004) and the Seaweed Industry Association of the Philippines showed that seaweed farming is one of the largest and most productive sources of income among coastal communities of the Philippines. Majority of the harvested seaweeds are either processed into carrageenan or simply sun dried (FAO, 2004) as a result, some of its essential nutrients are lost. It is well documented that extracts from seaweeds are abundant in polyphenolic compounds which are recognized for their antioxidant properties (Wang, Jónsdóttir, & Ólafsdóttir, 2009; Athukorala, Lee, Song, et al., 2003). Seaweed extracts also contain antimicrobial properties against major food pathogenic and spoilage microorganisms like E. coli (Gupta, Rajauria, & Abu-Ghannam, 2010). Seaweeds are known to be rich in important minerals such as iodine and dietary fibers (Kolb, Vallorani, Milanovic, &Stocchi, 2004). Moreover, there is a growing trend towards the use of "natural green" plant extracts in various food and beverages industry.

Seaweed, known for its structurally diverse bioactive compounds, can be used as an ingredient to supplement food with functional compounds. The concern of the application of such compounds as natural antioxidants, antimicrobials or texturing agents in different food products is being closely studied. Moreover, the utilization of seaweeds as food additives will lessen the use of chemical preservatives. The important role of diet in human health has recently been gaining attention. Functional food or food that is beneficial not just due to the presence of essential nutrients but also other properties which have been recognized for health promotion and disease prevention are gradually taking consideration in food industries. Beneficial effects of functional foods can be brought about by its mixture of antioxidant, antimicrobial, anticancer and antiviral activities. Seaweeds (*Eucheuma spinosum*) locally known as *guso* are abundantly growing in the Philippines especially in the Central and Eastern Visayas (FAO, 2004). Marine macroalgae are considered one of the richest sources of antioxidants (Chen, Lim, Sohn, Choi & Han, 2009). They are also a good source of vitamins and folic acid as well as minerals such as Na,Ca, K, P and I (Dhargalkar & Pereira, 2005). Sugars from seaweeds also possess prebiotics and other biological activities which could be useful for medical (Smit, 2004).

In many ASEAN countries, *Eucheuma* seaweeds are commonly consumed fresh like in salads. They are also processed into carrageenan a gelatinous extract from seaweeds used for their gelling, thickening, and stabilizing properties, however, current studies added their potential medicinal uses against cancer and other forms of diseases as one of its many benefits (Mohamed, Hashim & Rahman, 2011). Considering the abundant and growing supply of *guso* in the country and its many functional properties, it is therefore important to increase the consumption rate of this wonder seafood by producing other food products from it. The increase in demand of different food products from *guso* is expected to boost seaweed production in Eastern Visay as which will lead to generation of livelihood in the coastal communities. Developed food technologies have been used in extension programs by universities to improve economic status of its constituents (Pascual and Estolano, 2017). As a functional food, it will also promote good health among consumers. The increase in the usefulness of seaweeds just like

producing new food products from this raw material like fish ball will make its bioactive components readily available in ready to eat form. Thus, this study aims to develop fish balls with seaweeds and determine its' sensorial qualities as well as market potential.

II. MATERIALS AND METHODS

2.1 Procurement of Ingredients and Raw Materials

All ingredients in making fish balls as well as the seaweeds used in the study were bought from the public markets in Sogod, Southern Leyte.

2.2 Experimental Design

The samples in the study were laid out in Complete Randomization Design (CRD). Various levels of seaweeds (0, 25%, 50%, 75% and 100%) were used as treatments.

2.3 Preparation of the Product

2.3.1 Preparation of Fish

Fish were cleaned and cooked with following the procedure and ingredients: 0.60g black pepper, 200 mL vinegar, 30g ginger, 30g garlic, 1 teaspoon salt, 5g MSG, 1,500g fish, and 237 mL water were placed in a casserole with a cover and cooked for 30 minutes. After cooking, fish were placed in a plate and then shredded into flakes.

2.3.2 Preparation of Seaweed

Fresh seaweeds were blanched in boiling water for 10 seconds and were chopped into fine pieces and set aside before use.

2.3.3 Preparation of Fish balls

Fish balls were processed following the procedure of Fabian (2008). 250g of fish flakes was placed in a mixing bowl added with 100 of eggs, 30g chopped onions, 30g onion stalk, 25g chopped celery, 250g all – purpose flour, 30g baking powder, 5g baking soda, 30gsalt, 20g sugar, 1g black pepper and 30 mL evaporated milk. Then seaweeds were added into the mixture following the different treatment formulations and were thoroughly mixed using a wooden ladle. The mixtures were shaped into balls (30 grams) and were rolled over a plate with flour to hold its shape. The fish balls were then steamed for 15 minutes. The steamed fish balls were stored inside the freezer for 24 hours before cooking. The fish balls were cooked by deep frying them for 15 minutes or until golden brown.

2.4 Sensory Evaluation

All sensory evaluation activities were carried out to determine the acceptability of the fish ball products from the different treatments right after freezer for a day. Samples were evaluated by 60 sensory panels that assessed the products' color, aroma, flavor, texture, general acceptability. The standard procedures on concluding sensory evaluation by Mabesa (1998) was followed using the 9 – point Hedonic Scale. Sensory evaluation was replicated twice.

2.5 Production Cost and Selling Price Determination

The selling price per piece of fish balls was computed. The computation for the production cost and selling price were based on the following formula:

$$Unit\ cost = \frac{\text{Raw Food Cost}}{\text{Yield}} \quad (1)$$

$$\text{Selling Price} = \frac{\text{Unit Cost}}{\text{Food Cost Percentage}} \quad (2)$$

$$\text{Total Selling Price} = \text{Selling Price x Yield} \quad (3)$$

Where:

UC = Unit Cost

RFC = Raw Food Cost

FCP = Food Cost Percentage

Y = Yield

SP = Selling Price

TSP = Total Selling Price

2.6 Statistical Analysis

Data gathered from the experiment were subjected to Analysis of Variance (ANOVA) to determine significant effects among treatments. When treatments effects were found significant, Duncan's Multiple Range Test (DMRT) was used to determine the significant difference between treatments.

III. RESULTS AND DISCUSSION

3.1 Appearance of the Different Treatments

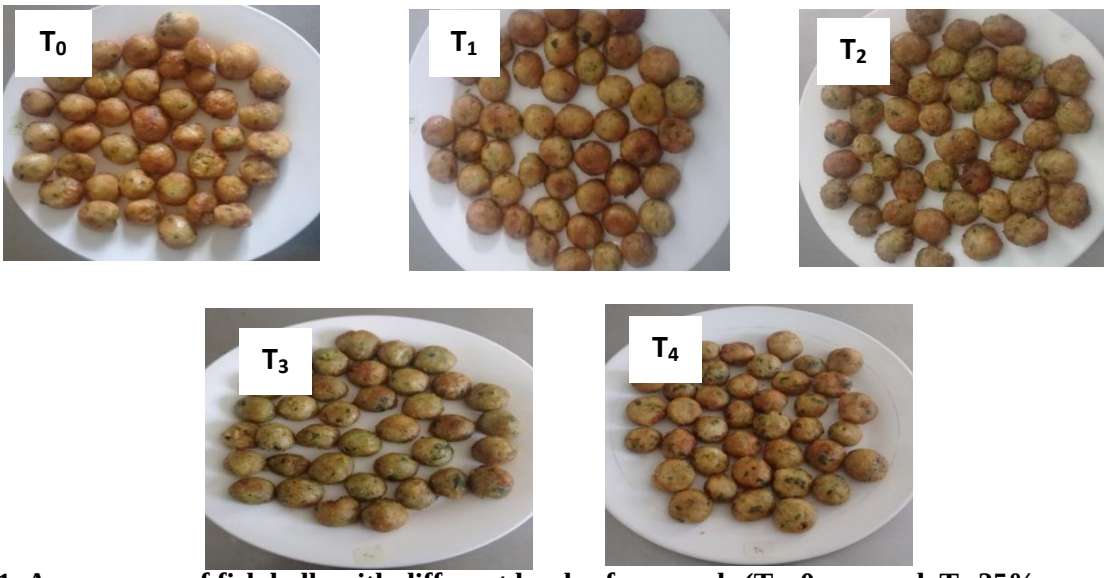

FIGURE 1. Appearance of fish balls with different levels of seaweeds (T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed)

3.2 Sensory Evaluation

TABLE 1
MEAN SENSORY SCORES OF THE DIFFERENT TREATMENTS USING 9-POINT HEDONIC SCALE

Treatment	Sensory Parameter*				
	Color Acceptability	Aroma Acceptability	Flavor Acceptability	Texture Acceptability	General Acceptability
T_0	7.80^{a}	7.61^{a}	7.23^{a}	7.33^{a}	7.36^{ab}
T_1	7.70^{a}	7.63^{a}	7.36^{a}	7.43^{a}	7.50^{a}
T_2	6.98^{b}	7.03^{b}	6.83^{ab}	6.96^{ab}	7.03^{abc}
T_3	6.63^{b}	6.95^{b}	6.35^{b}	6.31^{c}	6.50^{c}
T_4	6.88^{b}	7.00^{b}	6.55^{b}	6.66^{bc}	6.83^{bc}

T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed
****means with the same letters are not significantly different***
Hedonic rating scale: 9- like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2- dislike very much, 1- dislike extremely

3.2.1 Color Acceptability

The use of different levels of seaweeds significantly affected the color acceptability of fish balls as shown in Figure 1 and Table 2. Highest color acceptability was observed in T_0 (Control) with a score of 7.80. The color acceptability score of T_1 (25% seaweed) which is 7.70 was comparable to the control. The high color acceptability scores of both T_0 and T_1 could be attributed to its golden brown color, a color typical for fish balls. In contrary, as the levels of seaweeds was increased in the fish ball formulation such as in T_2 (50% seaweed) and T_3 (75% seaweed), the color acceptability of the fish balls significantly

decreased. This means that the addition of more seaweeds resulted to additional green color in the fish balls which consumers find it not likeable. Nevertheless, in terms of color acceptability, T_2, T_3 and T_4 scored fairly 6.98, 6.63 and 6.88 respectively which is within the range of "like slightly" to "like moderately" in the Hedonic scale

3.2.2 Aroma Acceptability

As presented in Table 1, the aroma acceptability of the different fish ball treatments was significantly affected by the various levels of seaweeds. The fish ball with the least amount of seaweed added (T_1) gave the highest aroma acceptability (7.63). The aroma acceptability of T_1 did not differ significantly from T_0. Moreover, the addition of more seaweed (T_2, T_3 and T_4) lessens the consumer acceptance of the fish balls in terms of aroma. It is important to note that the addition of small amount of seaweed improves the aroma of the fish balls but that increasing further the seaweed level decreases the aroma acceptability.

3.2.3 Flavor Acceptability

In terms of flavor acceptability, the different levels of seaweeds significantly affected the flavor of the fish balls (Table 1). The addition of small amount of seaweeds (25%) resulted to fish balls with the highest flavor acceptability (7.36). This could imply that seaweeds particularly in smaller amounts improve the texture of fish balls. Consequently, the addition of 50% seaweeds (T_2) also produced fish balls with comparable flavor with the control sample and T_1. The treatment with the largest amount of seaweeds (T_3) scored the least in color acceptability which is 6.35 but still falls between "like slightly" and "like moderately" in the Hedonic scale. This indicates that even the addition of larger amount of seaweeds could still produce fish balls that are still acceptable to consumers.

3.2.4 Texture Acceptability

As presented in Table 1, the texture acceptability of the different fish ball treatments was significantly affected by the various levels of seaweeds. The fish ball with the least amount of seaweed (T_1) gave the highest texture acceptability score (7.43). The texture acceptability of T_1 did not differ significantly from T_0 and T_2. Moreover, it is important to note that the addition of small amount of seaweed improves the texture of fish balls but that increasing further the seaweed level decreases the texture acceptability of the samples. Increasing the amount of seaweeds resulted to tougher fish balls in which consumers find it undesirable.

3.2.5 General Acceptability

In terms of general acceptability, the different levels of seaweeds significantly affected the sensorial qualities of the fish balls (Table 1). The addition of small amount of seaweeds (25%) resulted to fish balls with the highest general acceptability (7.50). This could imply that seaweeds particularly in smaller amounts improve the general acceptability of fish balls. Moreover, the addition of 50% seaweeds (T_2) also produced fish balls with comparable overall acceptability with the control sample. The treatment with the largest amount of seaweeds (T_3) scored the least in color acceptability which is 6.50 but still falls between "like slightly" and "like moderately" in the Hedonic scale. This indicates that even the addition of larger amount of seaweeds could still produce fish balls that are still acceptable to consumers. With the high acceptability ratings of the seaweed-fish ball samples, it can be introduce to school canteens however, its microbial safety and quality must be determined. In a study conducted by Pascual and Abenis (2016) in selected school canteens in Eastern Visayas, Philippines, 9 out of 15 public high schools showed poor sanitary practices leading to the presence of high number of microorganisms in foods served.

3.3 Production Cost and Selling Price Analysis

TABLE 2
COST OF PRODUCTION AND SELLING PRICE PER PIECE OF FISH BALLS*

Treatment	Production Cost (Php)	Selling Price (Php)
T_0	4.00	5.00
T_1	3.50	4.50
T_2	3.00	4.00
T_3	2.50	3.50
T_4	2.00	3.00

T_0- 0 seaweed, T_1-25% seaweed, T_2- 50% seaweed, T_3- 75% seaweed, T_4 – 100% seaweed
****30g sample***

IV. CONCLUSION

Based on the study conducted, the addition of seaweed has greatly affected all the treatment in terms of the color, aroma, flavor, texture and general acceptability. Comparing all treatments, T_1 scored the highest in all sensory parameters being evaluated. Increasing the amounts of seaweed added to fish balls resulted to decrease in sensory attributes however, lowers the production cost and selling price of the products.

RECOMMENDATION

Proximate composition analysis should be conducted on the different seaweed fish ball samples to have information about its nutritional contents. An expanded market research for the product or any product of similarity may also be important to validate and refine assumptions for the product entry in a well-defined market environment. Furthermore, market testing of the product must also be conducted. Further work on establishing the shelf life of the product must be conducted especially at longer storage period. Shelf-life study should also be conducted on packaged ready-to-fry seaweed (steamed) fish balls.

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Assessment of the Profitability Window of Broiler Chickens Farming in Bobo-Dioulasso, Burkina Faso

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Abstract— *The purpose of this study, was to determine the optimal size for broiler farming and the optimal hen's raising time to achieve technically and economically profitable farming .The study was conducted in the suburban area of Bobo-Dioulasso where three groups of six broiler farms were identified: the 1st group was made of farms that had 200 to 400 heads, the 2nd group had between 400 to 600 heads, and the 3rd group had more than 1000 heads.. In each group, three farms had completed the hen raising within 35 days and the other three within 42 days. We found that among the chicken coops, 17% respected the building orientation standards and most had low roofs (< 2.5 m) with a short extended eave (< 1 m) and a low dwarf wall (< 20 cm). Almost all of the producers (94.4%) used concomitantly a feed formula and a vaccination schedule. In terms of conduct, crawl space, lighting, preheating and heating were effective on all farms. In fact, 72.2% used coal-fired heaters, 16.7% radiant heater and 11.1% heating bulbs. Upon installation of the chicks (day 1), 76.5% of producers were administering veterinary products. In terms of good density of feeding and watering material, 61% were met at start-up, 43% at growth and 29% at finish. For those who observed the recommended density standards, 88.89% were encountered at start-up, 44% at growth and 5.2% at finish. The highest mortalities and average live weights (AVL) were found on large farms and 42 days raising while the highest Feed conversion ratios (FCR) were recorded in farms with 35 days of driving. The highest chicken production costs were seen in smaller flocks (1831±233) and the larger the flock size at finish, the better the profit (822 ± 151). In conclusion, the category of flock size that allowed the highest benefit for farmers in the suburban area of Bobo-Dioulasso is the group had more than 1000 heads and therefore should be recommended for extension purpose.*

Keywords— Bobo-Dioulasso-Burkina Faso, Norms, broiler Chickens, profitability.

I. INTRODUCTION

In Burkina Faso, the livestock sub-sector contributes 18.8% to GDP, 14.2% to exports, 38.8% to the formation of monetary income of rural households (MRA and UNDP, 2011) whereas poultry occupies a special place (DGPSE, 2010). In urban centers, semi-intensive poultry farming is a source of employment and provides workers with substantial income. In addition, poultry farming creates salaried jobs and contributes to the reduction of unemployment among youth. Also, poultry is the main source of animal proteins supply for populations (CILSS, 2006: Pousga *et al.,* 2019). However, total meat consumption in Burkina Faso is estimated on average at approximately 9 kg/inhabitant/year (PNSAN, 2013). This consumption is insufficient compared to the 21 kg of meat/person/year recommended (FAO, 2008). Indeed, the supply of meat is mainly ensured by endogenous extensive poultry farming which is characterized by its low productivity (Pousga *et al.*, 2019). Faced with an increase in the population, especially in urban area and the multiplication of mining sites, it becomes urgent to ensure a massive and rapid production of meat in order to cover the needs in animal proteins (Coulibaly, 2014). Modern poultry farming, including the production of broilers, seems to be a palliative solution (Hassan *et al.,* 2017, Hien *et al.,* 2018). However, the production of this chicken faces certain difficulties such as avian diseases, poor diet and poor housing (Amadou *et al.,* 2012). Actions that favored modern poultry farming and broiler chickens in particular remain insufficient and production still can't meet the growing needs of the market. Regarding the important economic and social role that chicken especially broiler chickens can play through its growth rate, further improvement actions, are necessary to sustainably increase its production. Our hypothesis was that the increased production would occur if farmers are able to derive a substantia financial advantage from the activity, which requires a good mastering of technical production route and better management of the inputs used. Our study therefore aims to determine the size of the broiler farm and the raising time-laps for achieving a technically and economically profitable farming in Bobo-Dioulasso suburban area.

II. MATERIAL AND METHODS

2.1 Study area

The study was undertook in Bobo-Dioulasso, capital of Houet province and the Hauts-Bassins region. The city is located in a south-Sudanian climate zone, characterized by average annual rainfall of between 900 and 1200 mm, and influenced by a dry season (October to April) and a rainy season (May to September). The dry season is composed of a cold period from late November to early February and a hot period from late February to April. The temperature varies from season to season and is (between 15 °C and 45 °C with an average of 28 °C.

2.2 Methods

2.2.1 Monitoring of farms

The method used was adapted from FAO's (1994) and was successfully used by Barakasa (1998), Some (2008) and Ouedraogo (2017). Briefly, the study took place in two (02) phases. (1) The first part consisted of inventory of the farmers involved in the production of broilers in Bobo-Dioulasso; (2) The second phase consisted of carrying out the monitoring at henhouses level. After the necessary explanations, the farmer themselves, with our support, followed the parameters of the birds. The monitoring period time-lapsed from October and December 2017 and concerned eighteen (18) producers installed in the commune, of which: six small farmers had a flock of 200-400 heads among which three (03) raised the broilers in 35 days and the other three in 42 days; six other medium farmers had a flock of between 400 and 600 heads of which three carried out raising in 35 days and the other three in 42 days; finally, the six (06) remaining big farmers had a flock of more than 1000 heads, of which three carried out their rearing in 35 days and the other three in 42 days. The parameters considered were: mortality, growth, feed conversion ratio, profitability of the activity.

2.2.2 Data Analysis

For analysis, data processing and generation of graphics, we used SPHINX v4.5, XLSTAT v2007.7 and EXCEL 2013 software's. The analysis of variance (ANOVA) was done and comparison of the means between the parameters (number of days of rearing and number of animals) was carried out using Fisher's test at the 5% threshold. For economic performances, we carried out an analysis of the profit by bands in each farm. The results obtained were subdivided into variable, structural costs and income. In terms of products, they corresponded to the income from the sale of chickens and manure at the end of the batch rearing. The sale was made per head at 2,250 CFA and 1,000 CFA/100 kg of manure. The total products were obtained by adding the sale of chicken and sale of manure.

Feed intake (FI)

FI= (FDD-FR)/ (Total number of animal): FDD = food distributed daily; FR= food refusal.

Feed conversion ratio (FCR) is the conventional measure of livestock production efficiency: the weight of feed intake divided by weight gained by the animal

FCR= FI/ (Weight gained)

Mortality= (Number of deaths in the batch)/ (Group size at the start of the experiment); Mortalities were recorded daily

With regard to economic profitability, the following formulas have been used: Avec FIt = the total Food Quantity Ingested by phase (Start-up, growth and finish).

Food cost / phase = FI * price per kg of food

Food cost = Σ food cost / phase

Chicken selling price = PV * price per kg at the farm

Sale of chickens = Number of chickens * selling price of chicken

Depreciation = ((Equipment acquisition cost))/ ((Number of years of depreciation))*((number of days of breeding))/ ((365 days))

Production cost = Σ expenses

Profits = income-expenses

Chicken profit = (Total profit) / (Number of chickens sold)

Chicken production cost = (Σ C) / (Number of chickens sold)

III. RESULT AND DISCUSSIONS

3.1 Result

3.1.1 Farming standards

3.1.1.1 Buildings

Among the eighteen (18) farmers involved in the study, the majority had their buildings located on the farm (61.1%), against 38.9% who had their buildings at home. The largest coop had 198 m2 with a length of 22 m, a width of 9 m, and a height of 4 m although the smallest coop had 8 m2 with a length of 4 m, a width of 2 m and a height of 2 m. Most of the coops had metal sheet roofs, were low (< 2.5 m) with a short extended eave (< 1 m) and a short wall of less than 20 cm height. All of the buildings had a concrete terrace. Some rare buildings had a capped roof. Also, only 17% of these buildings met the east-west orientation standards with the north-south openings which are the standards recommended in tropical countries. Almost all of the farm buildings involved in the study had fences and tarpaulins. Ventilation was natural in all eighteen (18) farm buildings.

3.1.1.2 Farming equipment

The use of light bulbs was effective in all buildings. The majority of poultry farmers (77.8%) regularly used a scale in their farms. The distribution of different heating materials used in hen houses were represented (Fig. 1). Briefly, 72.2% used coal-fired heaters, 16.7% radiant heater and 11.1% heating bulbs. The most widely used feeders in animal husbandry were plates, cone feeders and linear feeders. For the drinkers, we had the cone type which was used in all farms whose capacity was dependent on the age of the chicken. The most common litter on all farms was wood shavings.

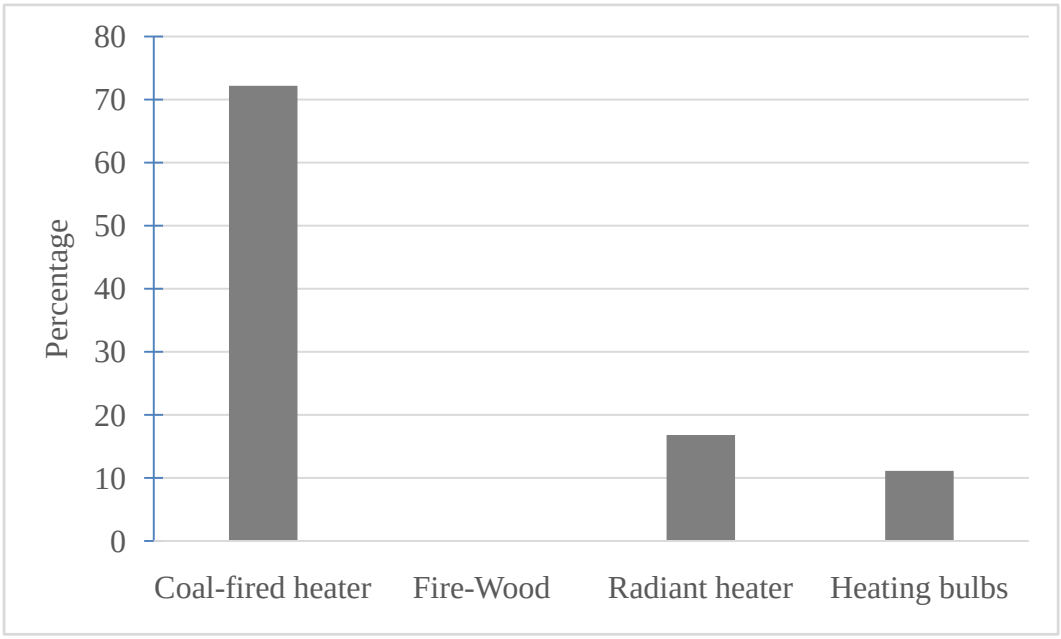

FIGURE 1: Heating source distribution

3.1.1.3 Feeding and watering

Almost all (94.4%) of farmers formulated ration themselves. Among farmers making their own poultry feed, 53.3% of them used three (03) different formulas depending on the stages of production (starter, growth, finishing) and 46.7% of them used two (02) formulas (starter and grow-finishing). Most of ration contained maize, cottonseed meal, fish meal, methionine and lysine. Figure 2 shows how the food is distributed in the different buildings. We have 27.78% of farmers who had specific feed times versus 72.22% who feed their broiler chickens ad libitum (Fig. 2).

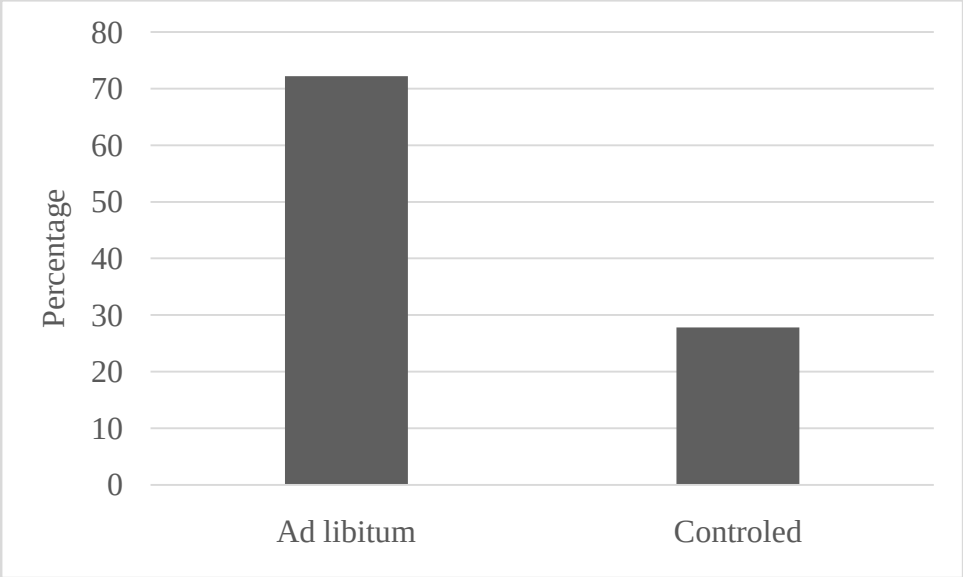

FIGURE 2: Regime of food distribution

3.1.1.4 Health monitoring

The most commonly used disinfectants were: bleach, Virkon and lime. Veterinary products used in almost all poultry farms included: anti-stress, vaccines against Newcastle disease, Infectious bursal disease and infectious bronchitis; Anticoccidial drugs and antibiotics against respiratory diseases, vitamin ABs used by some producers (11%) were administered under the supervision of veterinary agents.

3.1.1.5 Farm management

The production of broiler chickens was dominated by new farmers. In terms of management, it appears that 100% of farmers respected a crawl space lasting between three (03) days to a month. During this crawl space, hen-house, feeders and drinkers were disinfected. More than ¾ of famers (76.5%) administered veterinary medication as soon as the chicks arrived (on day-1) and 100% were distributing feed to the chicks from the first day of their installation. Heating was effective in all farms during start-up and continues in 11.1% of farms during growth. This heating is a function of temperature in 66.7% of farmers. A few farmers had thermometers in their coops to record the temperature. The proportion of farmers that respected density of feeders and drinkers in farms was represented (Fig. 3). Indeed, 61% complied with the standards of 50 chicks per feeder and / or drinkers at start-up, 43% the standard of 30 chickens per feeders and / or drinkers with growth and only 29% had a workforce of 10 chickens per feeder and / or drinkers at the finish.

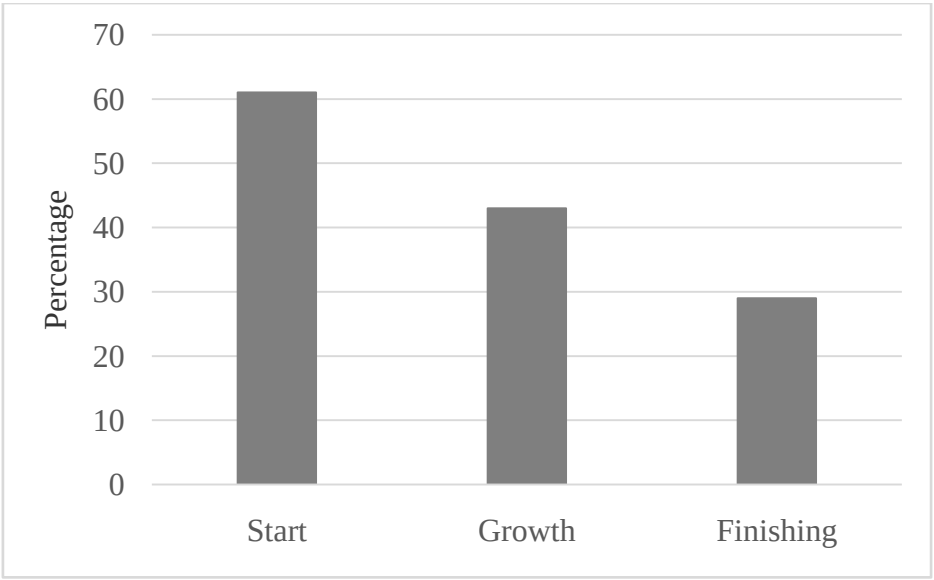

FIGURE 3: Compliance with the norms of density for feeding's material

Density of chickens in buildings showed (Fig. 4). In total, 88.89% of the farmers had a good density at the start (20 to 30 chicks per m^2), 44.4% at growth (10 to 20 chicks per m^2) and only 5.2% in the finish (8 to 10 chicks per m^2).

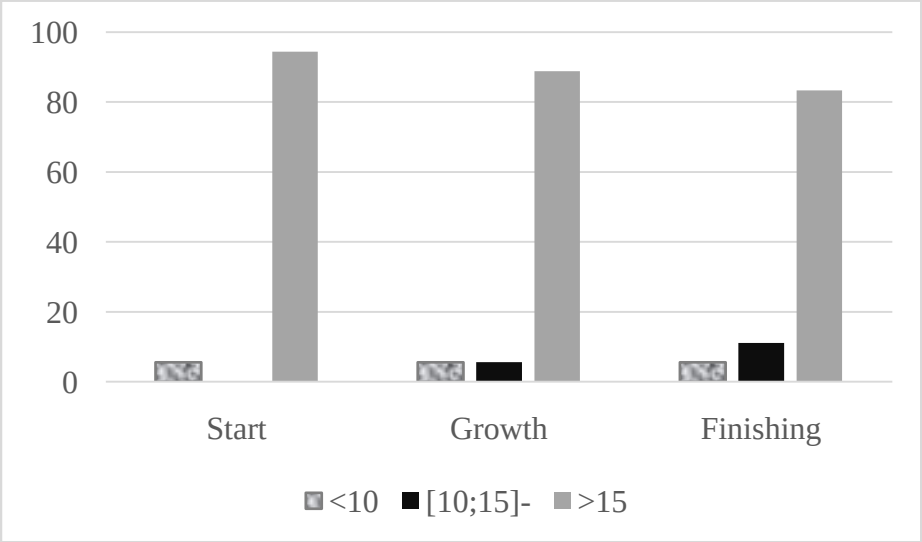

FIGURE 4: Compliance with density standards for chickens in buildings (number/m^2)

3.2 Zootechnical performance

3.2.1 Mortality

Table 1 showed the mortality rates according to stage and size of the farm. We found that they are higher at start-up and in large numbers.

TABLE 1
MORTALITY RATE (%) DEPENDING ON THE STAGE AND SIZE OF THE FARM

Designations	Farm size (head)			P Value
	200 - 400	400 - 600	1000 plus	
M. R. at Start-up (%)	1,36 ± 0,91 [a]	1,37 ± 0,42 [a]	2,21 ± 1,33 [a]	0,26
M. R. at growth (%)	0,63 ± 0,37 [a]	0,26 ± 0,48 [a]	0,41 ± 0,23 [a]	0,27
M. R. at finishing (%)	0,16 ± 0,46 [a]	0,13 ± 0,32 [a]	0,81 ± 0,66 [a]	0,05

On the same line, the values with the same letters (superscript) do not differ significantly (p> 0.05); significant at the 5% level (p <0.05).M. R.: Mortality rate

3.2.2 Average live weight

The average live weight (ALW) in 35 and 42 days relative to the total is presented in Table 2. For farm size between 200 and 400 heads, we recorded a MLW of 1600.6 g and 1766.6 g respectively for 35 days and 42 days. For farm size more than 400 heads, we noticed that the MLW did not vary regardless of the number of raising days. It is 1650 g at 35 days and 1966.6 g at 42 days.

TABLE 2
AVERAGE LIVE WEIGHT AT 35 DAYS AND 42 DAYS DEPENDING ON THE FARM SIZE

Designations	Farm size (head)			P Value
	200 - 400	400 - 600	1000 et plus	
ALW (g) à 35 days	1600,66 ±217,25 [a]	1650 ±86,6 [a]	1650 ±132,28 [a]	0,9
ALW (g) à 42 days	1766,66 ±208,16 [a]	1966,66 ±642,91 [a]	1966,66 ±635,08 [a]	0,87

On the same line, the values with the same letters (superscript) do not differ significantly (p> 0.05); Significant at the 5% level (p <0.05). ALW: Mean live weight

3.2.3 Feed conversion ratio (FCR)

The Feed conversion ratio (FCR) in 35 and 42 days depending on raising days are shown in Table 3. We observed that FCRs grew with flock size. The higher the flock was, the higher the FCR was. It appears that the 35-day Feed conversion ratio (FCR) are higher than those of 42 days.

TABLE 3
FEED CONVERSION RATIO (FCR) EN FONCTION DE LA TAILLE DE L'ÉLEVAGE

Designations	Farm size (head)			P Value
	200 - 400	400 - 600	1000 plus	
FCR (35 Days)	1,53 ± 0,68 [a]	1,70 ± 0,2 [a]	1,93 ± 0,15 [a]	0,06
FCR (42 Days)	1,43 ± 0,25 [a]	1,63 ± 0,21[a]	1,63 ±0,25 [a]	0,95

On the same line, the values with the same letters (superscript) do not differ significantly (p> 0.05); Significant at the 5% level (p <0.05). FCR: Feed conversion ratio

3.3 Assessment of financial profitability

3.3.1 Balance sheet

Table 4 recapitulates the products and expenses to give the profit of chicken by type of production.

TABLE 5
BALANCE SHEET

Designations		Income	Production cost	Profits	Broiler production cost	Chicken selling price	Chicken profit
Farm size	Days						
1 500	42	3 333 250	2 193 247	1 188 250	1 484	2 306	822
200	35	503 500	400 093	103 407	2 052	2 582	530
500	35	1 136 500	685 617	450 883	1 388	2 300	912
500	35	1 121 250	887 000	234 250	1 800	2 274	474
1 400	42	3 151 500	2 389 004	762 496	1 739	2 294	555
300	42	708 000	480 753	227 247	1 658	2 441	783
600	42	1 381 200	946 100	435 100	1 540	2 325	785
325	35	718 750	499 581	219 169	1 586	2 282	696
500	42	1 120 750	792 343	328 407	1 585	2 283	698
250	35	565 500	455 999	109 501	1 854	2 299	445
250	42	693 750	525 284	168 466	2 100	2 775	675
1 255	35	3 437 250	2 331 856	1 105 394	1 882	2 774	892
300	42	680 750	470 481	210 269	1 574	2 277	703
500	42	1 152 500	900 167	252 333	1 837	2 352	515
500	35	1 230 000	754 064	475 936	1 558	2 541	983
1 200	42	2 623 750	1 989 530	634 220	1 778	2 345	567
1 000	35	2 490 000	1 749 517	740 483	1 807	2 572	765
1 100	35	2 715 000	1 919 867	795 133	1 815	2 566	751

3.3.2 Analysis of the balance sheet

3.3.2.1 Production cost

The production cost per head of broiler chicken is given in Table 5. We noticed that the cost of production per broiler chicken according to flock size was zigzagging. The production cost varied from 1582 to 1835 CFA.

TABLE 5
PRODUCTION COST PER HEAD OF CHICKEN (CFA) DEPENDING ON THE SIZE OF THE FARM

Designations	Farm size (head)			P Value
	200 - 400	400 - 600	1000 plus	
PC at 35 days (CFA)	1830,66 ± 233,87 [a]	1582 ± 207,04 [a]	1835 ± 41,18 [a]	0,22
PC at 42 days (CFA)	1777,33 ± 282,57 [a]	1654 ± 160,07 [a]	1667 ± 159,67 [a]	0,74

On the same line, the values with the same letters (superscript) do not differ significantly (p> 0.05); Significant at the 5% level (p <0.05); PC. : Production cost

3.3.2.2 Broiler price

The selling price of broilers in relation to the flock size (Table 6) increased with flock size. Also, according to the raising days those who have a number of 42-day of raising sold broiler at a lower price than those limited to 35 days.

TABLE 6
BROILER CHICKEN PRICE (CFA) DEPENDING ON THE FARM

Designations	Farm size (head)			P Value
	200 - 400	400 - 600	1000 plus	
BP (CFA) 35 days	2497,66 ± 253,78 [a]	2371,66 ± 147,22 [a]	2637,33 ± 118,39 [a]	0,11
PB(CFA) 42 days	2387,66 ± 168,51[a]	2320 ± 34,77 [a]	2315 ± 26,66 [a]	0,3

On the same line, the values with the same letters (superscript) do not differ significantly (p> 0.05); Significant at the 5% level (p <0.05). BP: Broiler chicken price

3.4 Discussions

In Burkina Faso, several studies were carried out on broilers, but most often focused on diet, zootechnical parameters and health. Herein, in addition to these aspects, emphasis has been placed on profitability. The study has limitations because not all the expected performance of the chickens was achieved due to poor management of poultry farms. The farmer must have a good technical skill in order to avoid errors which could introduce pathologies and reduce performance and profitability of broilers (Cauquelin, 1957). The results of our work nevertheless constitute basic data for possible studies to improve the zootechnical and economic performance of broiler chicken farming in Burkina Faso.

3.4.1 Mortality

The mortality rates varied from 1.76% to 3.43%, and were less than the supposed accepted range (5 to 8%) (CIRAD, 2002). Also, others authors found similar mortality rates results: 1.2% with the Cobb 500 (Sanon, 2009); 2.5% with the Ross (Ouattara, 2008); and 3.5% (Ntivuguruzwa, 2008). These results were lower than mortality observed: 5.95% (Gnodogo, 2013); 8.82% (Kinda, 2014) 10.2% (Zongo, 2016) with Cobb500. These low mortality rates obtained might be due to the season that was be supposed to be advantageous for broiler farming. This agrees with Betene (2006) who finds that the mortality rate of broilers is low in the cold season (8%) compared to the hot season (12%). The highest mortality rates were recorded during start-up and in big flock. This is justified by the fact that the start-up is considered a delicate phase, since the sensitivity to pathogens of chicks is high. In addition, their immune system is still undeveloped. According to Kinda (2014),

the day-old chick is very fragile, it does not have its mother to warm it nor still enough possibility of defense against the cold. It is therefore essential that the farmer provides appropriate heating.

3.4.2 Average live weight

The highest average live weight was recorded on large farms where raising days were set for 42. The Average live weight (ALW) obtained (1600.6 to 1966.6 g) complied with those indicated in Mémento de l' agronome (CIRAD, 2002) (1600 to 1900 g) for tropical countries. These ALWs were similar to those observed in previous studies that varied between 1660 to 1743.8 g (Ngueba, 2006; Ouedraogo, 2017). Betene (2006) found lower performances of 1111.47 g in the hot season and 1159.02 g in the cold season. We should notice that other researchers obtained higher ALW: 2120.2-2280.4 g (Ciewe, 2006); 2405.2- 2501.9 g (Ntivuguruzwa, 2008); 2242-2328 g (Sanon, 2009); and 2085.8-2126.1 g (Sanni, 2014). These weight differences could be explained by disrespect of norms in poultry farming and especially the quality of the food distributed.

3. 4. 3. Feed conversion ratio

The feed conversion ratio (FCR) is an important economic criterion on the efficiency of food. The results obtained (1.4; 1.7 and 1.9 respectively for flock sizes of 200-400, 400-600 and 1000 in 35-days raising plan) showed that the FCR increases with the size of the flock. This may be justified by the fact that FCR can be overestimated during each week since it incorporates the losses linked to the wastage of the number of chicken and the errors of estimation on the real weight of the food used. Also, only 27.78% of farmers controlled the feed of broilers against 72.22% that feed ad libitum. In addition, the average FCR in 42 days (1.43) remains low compared to that of 35 days rearing plan (1.93). This proves that broilers valued the food better in 42 days than in 35 days raising plans. Most broilers in 35 days plan began with starter feed instead of the pre-start feed. This could cause the chicks to not value the feed well (Brian, 2019). These values are opposite to those of Betene (2006) and Zongo (2016) which reveal that the FCR increase with the number of days of rearing. In fact the chicks suffered a lot from long way transport and arrived too tired. AVIAGEN (2012) noticed that such a difficulty could negatively influence FCR. Nevertheless, these results remain lower than those reported in previous studies: 1.90 to 2.30 (Zongo, 2016), 2.1 to 2.2 (Ouedraogo, 2017) and 2.5 to 2.72 (Sanni, 2014) in 35 days. The results obtained in this study were closed to those of Ciewe (2006) (1.86 to 1.96), Ntivuguruzwa (2008) (1.9 to 2). The production period was between October and December, which is a favorable time in tropical climate for raising broiler chickens. SANOFI (1996) noted that when the temperature is oscillating between 32 °C to 36 °C, there is a decrease in the food uptake by 4.2 g/adult subject/day. Alloui *et al.* (2001), observed that chickens are unable to withstand heat. Which was not the case in our case.

3. 4. 4. Profitability

Almost all producers sold chicken per head at a price comprised between 2,250 and 2,500 CFA. The few producers who sold chicken per kg of weight did it at 1,500 CFA/kg. Compared to the local chickens of 1.5 kg sold at 3000 FCFA each, we assumed that broiler could be a boon for the urban population. The balance sheet allowed us to know that broiler farming generates an interesting profit for farmers because it is positive on all farms. Also, the study revealed that the cost of production per head of broiler in small farms was higher than in large farms. The price of broiler, was inversely higher in large farms than in small farms. It appeared that the benefit of broilers correlated to the number of subjects. In fact, the greater the number of broilers at finishing, the greater the profit per chicken head. That implied that the farms having the highest number of broiler chickens for sale were the most profitable. These results are explained by the fact that all medications were conditioned at 500 and 1000 doses. In addition, for flocks of the same size, those with a number of rearing days of 42 days registered a higher profit per broiler than those with 35 days. These values can be explained by the fact that zootechnical performance such as FCR is higher in 35 days rearing farms than in 42 days rearing farms and mortality is insignificant in the two types of rearing. This observation confirmed that slight differences in the FCR may have an impact on the financial margin (AVIAGEN, 2012). In addition, Leclercq and Beaumont (2000) asserted that by limiting wastage, productivity was increased through improved performance and reduced production costs. Betene (2006) suggested that by playing on the chicken selling price, we could increase revenue. Lame, stunted and malformed individuals are reservoirs and developers of potentially pathogenic microbes to other chickens. They constituted no-economic values which reduce the profit of the batch. However, regardless of the number of days of rearing or the size of the farm, the profit recorded was between 474 and 822 FCFA per broiler. These results are similar to those of Kabore (2017) who found 428 to 849 FCFA per broiler and superior to those of Ouedraogo (2017) and Zongo (2016) who recorded respectively 281 to 484 FCFA and 571 to 759 FCFA per subject. These high benefits are due to the rearing period which is the most comfortable for raising broilers. During that period, the heat induced mortality is lower and also the zootechnical performance such as FCR and ALW are good. This observation comforted Betene (2006) who found that the cost of poultry production increases with temperature.

IV. CONCLUSION

The aim of this work was to find the optimal broiler flock size to raise and the optimal number of days of rearing being economically profitable for farmer in Bobo-Dioulasso. A minimum of 1000 broilers per batch of flock size allowed the highest profit for farmers in the suburban area of Bobo-Dioulasso and therefore should be recommended for extension purpose. Further training and improvement of farmer skill of raising broilers may trigger increased benefit and should investigated. Also, a close monitoring of farms during hot and rainy season could shade light on the profitability.

V. CONFLICT OF INTEREST

There is no conflict of interest reported by the authors. The work was conducted under their supervision and each contributed to various aspects of the design, execution, writing, and review of the manuscript.

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Characterization of the Sweet Potato Production System in the Kou Valley in the Western Zone of Burkina Faso

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Abstract— *In the search for diversification of sources of income, producers have adopted the cultivation of sweet potato in their rotation, especially in irrigated plains. Despite the growing interest of producers for this crop, few results exist on the production systems as practiced by producers with a view to the sustainability of the activity.*

The present study aims to characterize the sweet potato production system on the developed perimeter of the Kou valley. To this end, surveys were carried out in the farming community on 30 farms. The results showed that sweet potato is cultivated in rotation with rice in the plain. One hundred percent (100%) of the producers surveyed practice rotation on their agricultural plot. Fertilization is a common practice, growers use NPK and Urea. Labor remains a concern for the crop for more than 80% of producers. Strengthening the technical capacities of producers would be beneficial through appropriate training.

Keywords— Sweet potato, sustainability, system, production, Kou valley, Burkina Faso.

I. INTRODUCTION

Agriculture of Burkina Faso is less and less productive and can no longer meet the basic needs of a growing population. The tubers which constitute the main edible part of the plant are rich in vitamins A, C, B and mineral salts (Low *et al.*, 2007; Burri, 2011). They are also used in many culinary preparations, and food industry uses it as a source of starch, or, in the form of flour, as a substitute for cereal flour (Sihachakr *et al.*, 1997; INSD, 2013; Koussoubé *et al.*, 2018). The leaves are eaten as a condiment or in the form of leafy vegetables, or as fodder for livestock (DGESS, 2014). In Burkina Faso, sweet potato cultivation has experienced increasing success over the past ten years, increasing from a production of 27,000 tons in 2001 to 141,000 tons in 2011, an increase of 400% (Traoré, 2014). Despite this relative importance of the plant, very few scientific results are available in Burkina Faso on the characterization of the crop as practiced by farmers with a view to improving its productivity. In a context of the impoverishment of rural populations, it is urgent to propose solutions in order to ensure the sustainability of production. This study is a contribution to a better knowledge of production systems based on sweet potato in order to ensure the sustainability of production systems in Burkina Faso. Specifically, our activities aimed to characterize the sweet potato-based cropping system on farms in the rice-growing plain of the Kou valley. This study was conducted under the assumption that the sweet potato cropping system varies depending on the availability of soil and the grower's knowledge of the plant.

II. MATERIALS AND METHODS

2.1. Study sites

The works were carried out in the developed perimeter of the valley. The perimeter is located 25 km northwest of the city of Bobo-Dioulasso on the Bobo-Faramana axis, border of Mali in the watershed of the Kou river between latitudes 11.35 ° and 11.41 ° North and longitudes 4.36 ° and 4.50 ° West with an altitude of 300 m.

2.2. Methods

2.2.1. Choice of experimental producers

Producers' perception of sweet potato production was collected through opinion surveys conducted in farming communities on the developed plain of the Kou valley, between January and May 2020. For this study, producers of both sexes were taken into account to constitute the basic sample.

The producers to be surveyed were selected in collaboration with the agent of the regional agricultural directorate in charge of the plain. Of the 200 sweet potato producers on the plain, a sample of 30 producers including 26 men and 4 women was selected to form the basis of our work. The database used for the selection of farms was obtained with the agricultural agents of the plain. The selection of producers to be surveyed was made in collaboration with producer groups and agricultural agents. This choice took into account two (02) criteria: (i) be a sweet potato producer, and (ii) be available for the investigation. The selected producers spread over the whole plain without any particular choice for part of the area.

2.2.2. Study procedure

A semi-structured questionnaire was tested beforehand with 5 producers of the developed plain of the Kou valley before its administration to the entire sample. The main aspects discussed focused on the farmer's knowledge of sweet potato production, variety acquisition, planting method, cropping system, fertilization, phytosanitary treatment, yields and use of post-harvest production. The administration of the questionnaire consisted of an interview with all members of the farm under the direction of the farm manager and a field visit to the sweet potato plot. The data collected were entered into the Excel 2007 spreadsheet, the analysis of variance carried out with the software XLSTAT-pro 7.5.2, version 2007. The means of the variables were compared using the Newman-Keuls test at the probability threshold. 5%.

TABLE 1
DOSE OF FERTILIZERS

Mineral Manure	0-50kg/ha	51-100kg/ha	l01-150kg/ha	More than 150kg/ha
NPK	37	3	0	3
Urée	43	30	7	10

Source: Survey result

The results in Figure 1 show that the addition of NPK significantly increases yields. These results are identical to those in the literature which indicate that the addition of a compound fertilizer improves productivity.

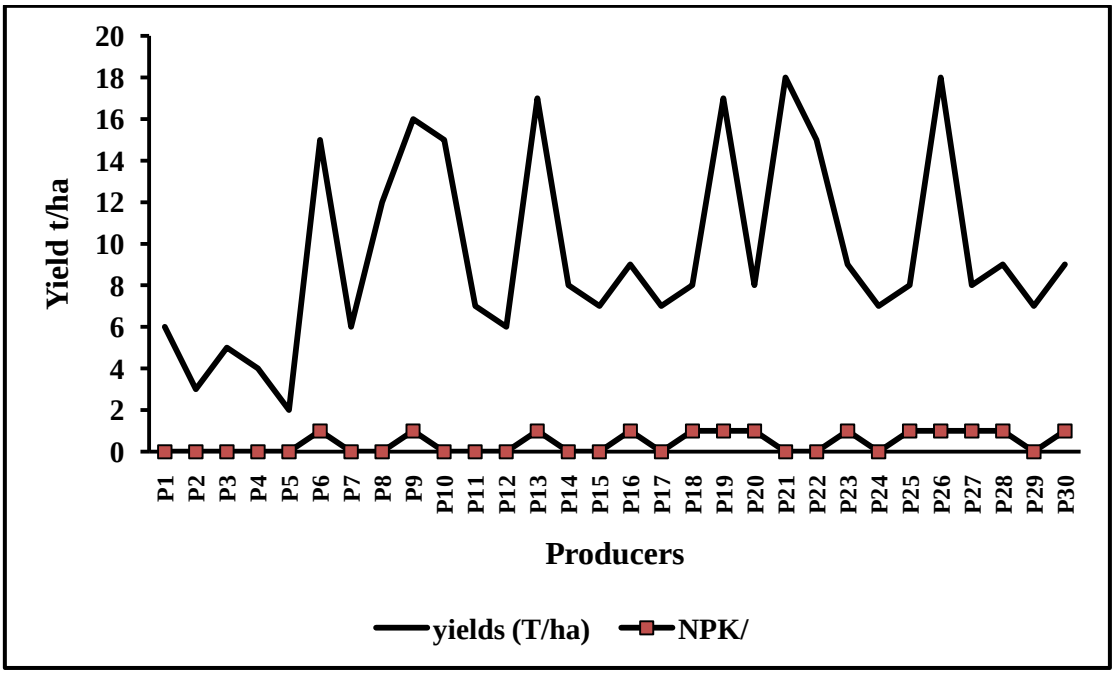

FIGURE 1: Interaction between yields and area of sweet potato fields

2.2.3. Dose of organic manure used

In order to improve the fertility of their soil, the majority of producers use organic manure, in this case, animal excrement, during soil preparation (Table 2). The quantities used vary according to the producers but would be greater than 1ton for 67%

of the respondents. The use of compost is rare and is limited to 3% of respondents. The use of raw manure could be a constraint because it could lead to more grassing or burns of the seedlings by excess potassium or ammonia.

TABLE 2
USE OF ORGANIC MANURE ON SWEET POTATO

Organic Manure	0,1-0,5 t	0,5-1 t	1-5 t	5-10 t
Compost	0	0	0	3%
Animal waste	6%	7%	37%	30%

Source : Survey result

2.3. Harvest

2.3.1. Harvest times

The results of the survey showed that the harvest periods are between 90 (for 70%) and 120 days after planting (for 30% of growers). The harvest is manual and is done using the daba.

2.3.2. Harvest destination

Only 4% of producers consume their production. In general, producers indicate that they package the harvest in part in 100 kg bags which are sold on site at the field level. The rest of the production is sold on the local market in small heaps at a price of 100 to 500 CFA. The proceeds from the sale allow producers to meet the needs of the family (education, health, nutrition, and clothing).

2.3.3. Constraints on sweet potato production

The results of the survey show that 100% of respondents are faced with a lack of financial means for the acquisition of inputs (Table 3). It should be noted the absence of supervision of producers on the technical itineraries of the cultivation of sweet potatoes. Labor remains a concern for the crop for more than 80% of producers. All (100%) of the producers are confronted with a lack of storage warehouse for harvested products. Producers point to the strong fluctuation in prices as one of the major constraints and a slump in the market of the village.

TABLE 3
CONSTRAINTS LINKED TO SWEET POTATO PRODUCTION

Constraints	Constraints frequency (%)
Acquisition of inputs	100
Harvest / labor	80
Potato storage	100
Potato sale	100

Source : Survey result

2.4. Suggestions and Proposed solutions

Producers need a reduction in the cost of inputs and their physical availability (Table 4). They think it would be essential for cooperatives to get involved in the management of inputs. In addition, producers seek agricultural loans to purchase inputs and subsidize the construction of storage warehouses. Suggestions were made on strengthening the technical capacities of producers through appropriate training, including conservation of sweet potato, soil fertility management, production of organic manure and the organization of producers into groups.

TABLE 4
SUGGESTIONS AND PROPOSED SOLUTIONS

Suggestions	Frequency of producers %
Reduction of input costs	80
Availability of inputs	14
Involvement of cooperatives in input management	06
Facilitate loans to producers	10
Subsidize the construction of storage warehouses	60
Sweet potato Conservation Training	30
Training on soil fertility management	40
Production of organic manure	10
Organization of producers	50

Source : Survey result

III. DISCUSSION

All of the producers surveyed practice rotation on their plot. This could be explained by crop productivity and soil fertility management. The added mineral fertilizer present on the potato crop which follows the rice cultivation has a positive rear effect. According to Bado, (2002), the lack of rotation in cropping systems leads to a monocultural practice with multiple drawbacks on the absorption of some mineral elements. Crop rotation is cited as a method of controlling the main enemies of sweet potato (Koussoubé et al, 2018). The period of planting sweet potato varies according to the season and the producers. According to the producers, various doses of fertilization are adopted at the level of the plain according to the poverty of the soils. These results are in agreement with those obtained by (Ebregt *et al.*, 2004a). Proportion of producers who use organic and inorganic fertilizers is high in areas where soils are poor. On the other hand, in the opinion of some authors, the sweet potato grows well on poor soils and does not require a significant input of organic and / or inorganic fertilizer (Ebregt *et al.*, 2004b) and (Stathers *et al.*, 2013). Improving potato yields would be linked to the addition of mineral or organic manure. These results are identical to those of (Koussoubé et al, 2018) and Stathers *et al.*, (2013) which indicate that the addition of a compound fertilizer improves the productivity of the sweet potato. The use of compost is rare in the production of sweet potato. The use of raw manure could be a constraint because it would lead to more grassing or burns of the seedlings by excess potassium or ammonia. The lack of supervision of producers on the technical itineraries of sweet potato cultivation could be justified by a lack of organization of producers in groups or cooperatives. Moreover, this could be justified by a lack of monitoring of agricultural development services. This situation could be improved by strengthening the technical capacities of producers through appropriate training. The results indicate a single maintenance for the most part during the plant cycle. Our results are in agreement with those obtained by Baziemo (2016) and Kpangnané (2016) which has shown that the control of grass cover is an element of the technical itinerary, reasoned by the farmer according to his production objectives.

IV. CONCLUSION

This study aims to characterize the sweet potato production system and propose improvement options to producers. The sweet potato appears as a crop of the future and is part of the development strategies of the Burkinabè government for achieving food security and improving the incomes of rural populations. Despite the efforts made by the development, research and production services of this speculation remains limited. The cultivation of sweet potato is confronted with several difficulties which result in a drop in its productivity. This study is a contribution to a better knowledge of sweet potato production systems capable of promoting its cultivation and increasing its production at the national level. The results of our work from the investigations carried out at the level of the developed perimeter of the Kou valley show that the sweet potato is cultivated in rotation with rice and the sweet potato plants receive fertilizers. In perspective, it will be necessary to continue work on the characterization of sweet potato production systems in other climatic zones in order to provide accessible and inexpensive options for rural populations.

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Short Communication

Interactive Association of fungus and root-knot nematodes on Sarnalli crop (*Ipomea Reptans*)

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Plants develop close association with many soil microorganisms especially with fungi and nematodes under field conditions that are either beneficial or harmful to plants. (Goswami et al., 2000) The fungus nematode interactions are numerous, varied and provide open field for significant research. (Goswami and Mittal, 2002) Fungus is an essential component of the interacting system of fungus—nematode complex disease and plays an important role in the disease etiology. Since the publication of Atkinson's report (1892) that *Fusarium* wilt of cotton was more severe in the presence of root-knot nematode (*Meloidogyne* spp.) than in its absence, a large volume of data has been accumulated to date which firmly establishes the involvement of plant-parasitic nematodes in interactions with fungal plant pathogens on various crop plants. (Mittal and Goswami, 2002) In the present paper an attempt has been made to study the fungi associated with root-knot nematodes from trans-Yamuna river belt of Delhi infecting Sarnalli crop (*Ipomea reptans*).

Sarnalli is a very popular leafy vegetable belonging to Family Basellaceae and eaten in Bihar, West Bengal, Orissa and North eastern states. This leafy vegetable like Palak (*Spinach spp*.), Poi (*Basella rubra*) and Chaulai (*Chinopodium alba*) is very rich in minerals, vitamins A and C. It also supply the essential roughage required in our daily diet. During a survey in trans-Yamuna river belt of Delhi ten soil and root samples were collected from Sarnalli crop and processed for nematode and fungi associated with this vegetable. In the present investigation, soil and root samples were analysed for nematodes as well as fungi. On closer examination, the roots were found to be heavily galled with root-knot nematode which on the basis of perineal pattern was identified as *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949. Several soil fungi were found to be consistently associated with rhizosphere and egg-masses of root-knot nematode on Sarnalli crop. The eggmasses were handpicked and transferred to sterile water and then examined under stereoscopic microscope. These egg-masses were surface sterilized with 0.1% mercuric choride for 20 seconds twice and then, washed again in sterile water. The eggmasses were transferred in Potato Dextrose Agar slants and incubated at 25 $\pm$ 2 C for 10-15 days while the soil fungi were processed with soil dilution plate method. The fungal colonies thus appeared were isolated, purified and identified. Thus, on an average 3.7 J_2 of *Meloidogyne incognita* per g soil was found along with a number of fungal bioagents like *Chaetomium indicum, Alternaria alternate, Aspergillus niger, Rhizoctonia solani, Rhizopus, Penicillium citrinum* isolated from the rhizosphere of root-knot infected Sarnalli crop by soil dilution plate method. *Penicillium crysogem* and *Graphium* spp. was found from the eggmasses of root-knot nematode. This is the first record of interactive association of *Meloidogyne incognita* infestation and fungi on leafy vegetable like Sarnalli crop. The root knot interaction with fungi associated on Sarnalli crop needs further extensive studies to ascertain the role of each organism individually and in combination on plant growth and yield.

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