International Journal of All Research Education and Scientific Methods (IJARESM), ISSN: 2455-6211
Volume 10, Issue 4, April-2022, Impact Factor: 7.429, Available online at: www.ijaresm.com

A Review on Bioactive Metabolites and Health Benefits of Brihatpilu (*Salvadora persica* L.):A Medicinally Important Plant

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ABSTRACT

Brihatpilu (Salvadora persica L.) of the family Salvadoraceae, and evergreen occurs in shrub savannah. It frequently used as a toothbrush and used in oral hygiene, medicine, cosmetics, food, fuel and even in pharmaceutical industries for preparation of 'Meswak' toothpaste.The present review gives a comprehensive outline of the bioactive chemical constituents and their health benefits of this species. The plant extracts are hopefully safe as evident from its ethonobotanical and ethnomedicinal studies, and exhibited various pharmaceutical effects such asantibacterial, analgesic, antioxidant, antigingival irritation, antiviral, antiulcer, anticonvulsant, antifungal, abortifacient, antiplatelet-agression,antifever, anti-ulcerogenic, anti-caries, antidepressant, hypolepidemic,and wound-healing.

Keywords: Salvadora persica,Meswak, Bioactive metabolites,Pharmaceutical effects.

I. INTRODUCTION

The present attempt is focused on bioactive metabolites of *S. persica* and their potential pharmaceutical applications. It is a multi-purpose medicinal plant of the genus *Salvadora* widely distributed in Asia and South Africa[1] and has been traditionally used for various ailments likeanticonvulsant, antiulcer,gastric troubles, and sedative effects in different regions of the world[2,3,4]. In addition, very familiar administration of this plant is for dental hygiene which has been utilized for centuries in somecountries, a practice also supported by World Health Organization[5,4].

Nowadays, a rising interest in the use of natural products, principally those derived from plants has been clear. Kind of reasons are behind this interest of plant produced compounds, number of plants are remain unscreened for chemical compounds and biological effects and long back history of traditional system of medicine imply safety and efficiency of natural products use and also specified pharmaceutical targets[6].The beneficial effects of meswak in oral hygieneand dental health are partially due to its mechanical action and principally due to pharmacologic effect from its composition of different bioactive metabolites[2]. For instance, presence of benzyl-isothiocyanate from roots of *S. persica*contains alkaloids, β-sitosterol,and small amount of resins, m-anisicacid,saponins, salvadourea, tannins,and trimethylamine constituents reported by[2].

II. DESCRIPTION OF*S. persica:*

*Salvadora persica,*belongs to Class Magnoliopsida(family: Salvadoraceae)commonly known as Pilu, Bhrihatpilu, and Meswak and 10 speciesdistributed mainly in the tropical and sub-tropical regions of Africa andAsia[7].It is a medium-sized tree orshrub with long and drooping branches, warped trunk, seldom more than 0.3 – 0.5 m in diameter[8].The leaves are glabrous, lanceolate, sub-succulent, 3–10 cm long, 1–3 cm wide, rounded to acute at apex, cuneate tosub-cordate at base[9]. The plant has a pleasant smell and pungent taste. Flowers are small, greenish–whitewith lateral and terminal panicles up to 10 cm long.Fruits are drupes,red to dark red purple in colour, aromatic, edible, and slightly sour in flavor, sweet on ripe, and with or without seeds containpale-yellow solid fat,lauric andmyristic acid,and 1.7–1.9% sugars on ripe[8,9]. Additionally, pale-yellow solid fat, rich in lauric andmyristic acids which is used in the preparation of soaps,illuminants, varnishes, paints as well as in food industry and it is recognized as nonconventional oil seed tree[9].

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III. BIOACTIVE METABOLITES

Under phytochemical investigation, all the parts (root, stem, leaves, and fruits) of *S. persica* have been screened (Table 1). An extensive bioactive metabolites analysis revealed the presence of alkaloids, flavonoids, furans, glycosides, phenolics, sterols, saponins, tannins, and terpenes consists ofα-caryophyllene, β-pinene, Benzyl isothiocynate, 1,8-cineole, D-limonene, linalool, liriodendrin, lauric acid, m-anisic acid, myristic acid, persicaline, palmitic acid, salvadoricine, salvastearolide, salvadourea, salvadoside, salvadoraside, syringin, and quercetin[6] (Fig. 1).The recent studies have reported some additional identified metabolites from Meswak like butanediamide, N1, N4-bis(phenylmethyl)-2(S)-hydroxybutanediamide(I), N-benzyl-2-phenylacetamide (II),N-benzylbenzamide (III), oleic,linolic, and stearic acids, benzyl nitrile, eugenol, thymol, isothymol, eucalyptol,isoterpinolene, fluoride, thiocynate, trimethyl amine, saponins, sterols, lignan glycosides, rutin, and quercetin etc. The principal metabolite from the essential oil of Meswak stem have been identified as 1,8-cineole(eucalyptol) (46%), α-caryophellene (13.4%), β-pinene (6.3%), and 9-epi-(E)-caryophellene[6,7,10,11].

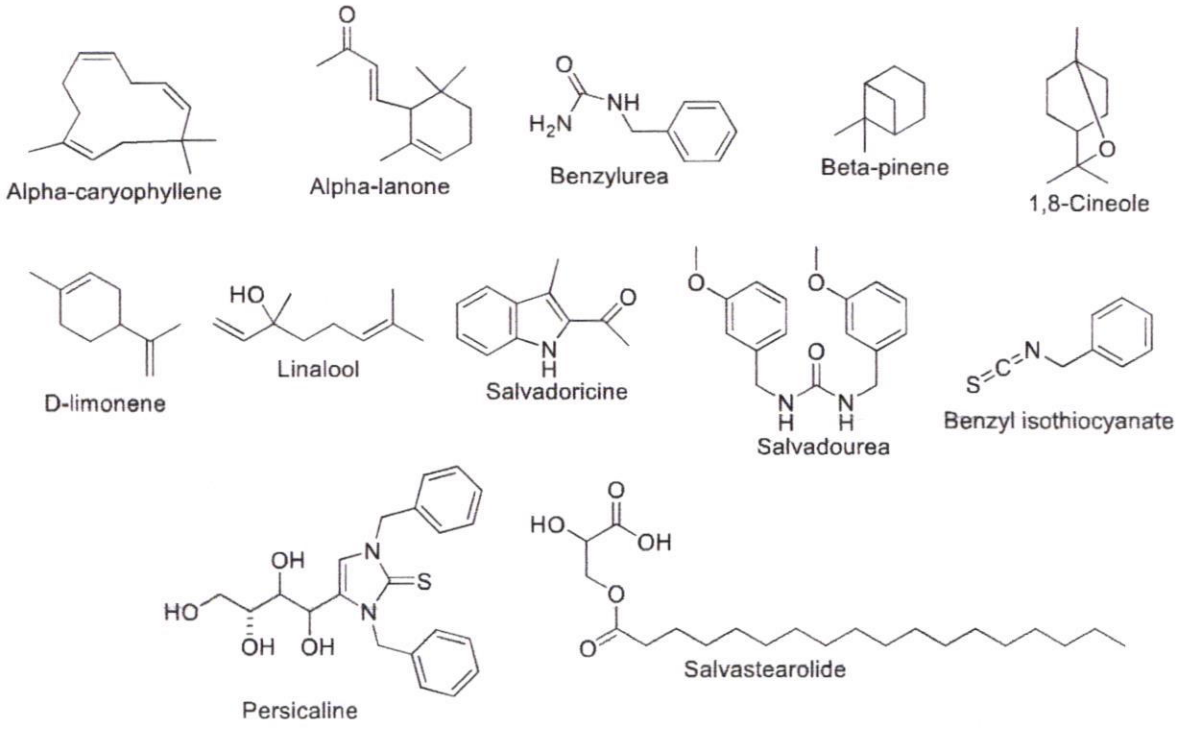

Fig. 1 Phytochemical constituents of *Salvadora persica*

IV. PHARMACEUTICAL ACTIVITIES

A. Antibacterial activity

Several studies have reported that root, stem, leaves, and fruits of *S. persica* possess bactericidal effects. Likewise, El-Hefny et al.[10] has reported the potential antibacterial effects of leaf, stem and root wood extracts of *S. persica* against phytopathogenic bacterial strains such as *Bacillus pumilus, Dickeya solani,Enterobacter cloacae, Pectobacterium caratovorum* (ippbc038), and *Ralostonia solanacerum* by using the disc diffusion method.Previous reports suggested that, S. persica exhibited significant antibacterial activity against bothaerobic as well as anaerobic bacteria collected from teeth by differentresearchers in the various parts of the world. For instance, S. persica aqueous extracts were effective against *Streptococcus mutans*and *Streptococcus faecalis*[7,12,13].The strongest bacterial action wasrecorded using the aqueous extract against S. faecalis (ZOI: 22.3 mm; MIC: 0.781 mg/ml) and the extract of S. persica is found to beeffective against bacterial pathogens such as *S. pyrogenis, S. faecalis, P. aeruginosa* and *Lactobacillus acidophilus*[7,14,15]. Sharma et al.[9] has evaluated the bactericidal potential of aqueous extractof S. persica against growth of Candida albicans, Streptococcus sp. and Staphylococcus aureus that may be associated to its high sulfate composition. Moreover, Enterococcusfaecalis is the most sensitive microorganism affected bythe use of aqueous extracts of S. persica, and it is

noticed that no significantdifference was recorded in the antibacterial effects of freshly cut and 1-month-old stems.The antibacterial activityof methanolic extract (200mg/ml) of arial part of S. persica against bacteria (S. aureus and Streptococcus sp.) isolated from dental plaque of patient[16].

B. Analgesic effect

Khatak et al.[2] has reported the analgesic activity of S. persica decoctionwhen injected into mice. They observed that S. persicadecoction was found moreeffective against thermal stimuli than chemical stimuli.Hoodaand Pai [17] has studied analgesic effects of hydroalcoholic root extract of S. persica onalbino mice and albino rat model using Eddy's hot plate (400 mg/kg orally for 90 minutes) and tail immersion methods (400 mg/kgorally for 90 minutes), respectively.

C. Hypolipidemic activity

The stem sticks of *S. persica* are widely used in oral hygiene and stem decoctions exhibits reduction in cholesterol composition in human being. Use of *S. persica*decoction tested in diet induced hypercholesterolemic rats.Theresults showed that, the *S. persica* decoction significantlylowered cholesterol and LDL plasma levels in the rats, provingto be the decoction possess hypolipidemic effect.Khatak et al.[2]has evaluated influence of decoction prepared from S. persica was found to be significantly effective (27 hrs treatment) for the reversal of increased plasma cholesterol and triglyceride levels induced by Triton.

D. Hypoglycemic activity

On consideration of presence of phytochemical constituents of Meswak, administration of various extracts of Meswak in rats exhibited potential hypoglycemic effect[18].

E. Anti-inflammatory activity

Ahmad et al.[7] has reported strong anti-inflammatory action on exposure of S. persica extracts to the two different groups of Albino rats (Male & Female). The extracts and standard drugs are orally administered an hour prior to carrageenan injection. Indomethacine was used as standard component. Rao et al.[19]has studied anti-inflammatory effect of S. persica.Thestudy reported that, thebetter anti-inflammatory action in the4 htreatment after the administration ofethanolic extract of S. persica sticks in rats inflammation induced by standard drug aspirin with 500 mg/ml dose[20].

F. Anticancer activity

Kumar and Sharma[21]has evaluated oral anticancer activity (PE/-CA-PJ15 and PDC fibroblast cancer cell line)of aqueous extract of S. persica which results in the cytotoxicity effect becomes significant at 11.25mg/ml concentration of plant extract. Aqueous, acetone and ethanolic extracts of leaves, bark, and fruit peels of S. persica exhibited potential anticancer activity was evaluated using the HeLa cell line. Among all the tested extracts, ethanolic leaves extract was found to be the best for anticancer potential of S. persica[19,21]. The effect of aqueous and methanolic extract of S. persicastem was evaluatedas antitumor agent and as a result, tested extracts of S. persica was indicated significant antitumor activity at 400µg/ml concentration[22].Iyer and Patil[23]have evaluated in vivo antitumor potential of isolated antitumor agent coumarin from S. indica stem in hybrid mice model(Swiss albino strain and C57BL strain). The results showed that, tumor growth was delayed byenhancing volume doubling time, growth delay, and mean survival time.The root extract of Salvadora persica exhibited potential anticancer action against human hepatoma (HepG2) cancercell line and also showed positive impact in the treatment of hepato-cellular carcinoma in human[24].

G. Antiulcer activity

Decoction of S. persica possessed showed significant protective activity against ethanol and stress-induced gastric mucosa ulcers in rats was evaluated by using opticalmicroscopy[8].Labeda et al.[11]haveevaluated the protective effect of S. persica root extract (dose 200 mg/kg and400mg/kg) against chilled absolute ethanol (dose, 5 ml/kg)induced gastriculcer in the male adult rat.The root decoction (500 mg/kg) of S. persica exhibited antiulcer effect against acetyl salicyclicacid (200 mg/kg for three days treatment) induced ulcer in male Wistar rat. The results showed that the ulcer index of treated rats was decreased by 11.4± 2.3 to 0.9±1.6 and confirmed using microscopic studies[21,25].

H. Anticonvulsant activity

The stem extracts of S. persica was showed anticonvulsant effect on rats. The extracts of S. persica extended sleeping-time

and decreased induction-time induced by sodium pentobarbital; also exhibited protection against PTZ-induced convulsion by increasing the latency period and diminishing the death rate in mice[8].Likewise, Khatak et al.[2] has studied the effect of stem extract of S. persica exhibited anticonvulsant effects, thereby stem extracts showed protection against PTZ-induced convulsionby increasing the latency period and declining mortality rate in rats.

I. Antifungal activity

Fungicidal effect of Meswak extracts at concentration of 15% and above for maximum 48 hours of exposure. The significant fungicidal potential of Meswak extracts exhibited was probably due to presence of one or more root metabolites includesalkaloid resin, trimethylamine, and sulfur compounds is reported by Al-Bagieh et al.[26]. Likewise, the diluted acetone extract (300 mg/ml) of dry S. persica showed significant results against oral fungal infections caused by *C. albicans, C. glabrata* and *C. parapsilosis* strains screened by using disc diffusion and micro-dilution assays[7].

J. Abortifacient activity

The extract of S. persica did not have much effect on female mice fertility, although it caused a significant decrease in the relative weights of the ovary and an increase in the weights of uterine. The results indicate that, the extract of S. persica has adverse effects on male and female reproductive systems and fertility[8].Darmani et al.[27]and Kumar and Sharma [21]has reported that, the antifertility effectof ethanolic extract of S. persica sticks (oraldose 800 mg/kg of extract for 30 days) on the fertilization of male and female mice. Treated male mice resulted in an increase inweight in testes and preputial glands and decreased in seminalvesicles. Treated females resulted in a decrease in ovary weightand an increase in uterine weight and no change in embryo weight. The study claimed that the number of pregnanciesin females impregnated by the treated male was decreasedto compare withcontrol male.

K. Cytotoxicity effect

Literature survey suggested that, extracts of S. persica showed cytotoxic potential on gingival and other periodontal structures and no cytotoxic effect has been exhibited by a freshly cut and freshly used S. persica. Based onthese research findings it is suggested that the used portion of the S. persica should be cut after it has been used for a day[8].The cytotoxic effect of plant extracts became evident only after 24h exposure because the agar overlay method depends on the dispersion ofthe extracts to the agar medium[2].

Table 1. Biologically active metabolites composition of *Salvadora persica*

Compound	Biological activity	References
Tannic acid	Reduces the clinically detectable gingivitis andplaque and gingivitis	[7,28,29,33]
Benzyl isothiocyanate, benzyl nitrile,carvacrol, benzaldehyde, aniline and naphthalene	Dental hygiene effects	[7,30]
Salvadorine	Antibacterial effect and stimulatory action on the gingival	[7]
Benzyl nitrate and Benzylisothiocyanate	Antiviral, antibacterial and anti-fungal agents	[7,31]
Butanediamide, N4-bis(phenylmethyl)-2(S)-hydroxy-butanediamide	Antibacterial agent against gram positive and gram negative bacteria	[32]
N-benzyl-2-phenylacetamide	Antiplatelet aggregation effect in human, and antibacterial activity against *E. coli*	[7,32]
Alkaloids	Antimicrobial agents	[6]
Flavonoids		[6,33]
Glycosides	Antimicrobial agents	[7]
Phenolics		[6,33]
Saponins	Antimicrobial agents	[6]
Terpenes	Antimicrobial agents	[6,7]

Salvadourea, m-anisic acid	Anti-viral, antiparasitic activity	[8,34]
Octacosanol, Triacantanol, β-sitosterol, Glucopyranoside	Antimicrobial, analgesic, anti-fertility, sedative, antiulcer effects	[8]
Lauric, myristic and palmitic acids, phenols, furans, sterols, glycosides, salvadoside, salvadoraside, syringin, liriodendrin, Quercetin, and flavonoids rutin	Antimicrobial action	[7]
α-caryophyllene, Benzyl isothiocynate, Linalool, D-limonene, salvadoricine, persicaline, salvastearolide, β-pinene, 1,8-cineole, salvadourea	Wound-healing, antioxidant, analgesic, anti-inflammatory, sedative, and antidepressant effects	[6]

CONCLUSION

Bioactive metabolites composition and pharmaceutical activities ofvarious parts of *Salvadora persica*(Meswak) were analyzed.Depending upon the phytochemical constituents, the *S. persica*has distinctivehealth advantages. The present study suggests that different parts of *S. persica*is a potential source of various bioactive metabolitesand has promising pharmaceutical effects.Moreover, the potentialantibacterial, analgesic, antioxidant, antigingival, antiviral, antiulcer, anticonvulsant, antifungal, abortifacient, antiplatelet-agression, antifever, anti-ulcerogenic, anti-caries, antidepressant, hypolepidemic,and wound-healingactivities of the various parts extracts of *S. persica* may be attributed for the presence of α-caryophyllene, β-pinene, Benzyl isothiocynate, 1,8-cineole, D-limonene, linalool, liriodendrin, lauric acid, m-anisic acid, myristic acid, persicaline, palmitic acid, salvadoricine, salvastearolide, salvadourea, salvadoside, salvadoraside, syringin, and quercetin. This study demonstrate the presence ofalkaloids,phenolics, furans, sterols, glycosides, flavonoids metabolites which brings out the nutritional potential of the plant for overcoming the nutritional deficiency and future research would consider large scale cultivation is recommended on the basis of its high medicinalpotential.Furthermore, the higher phyto-chemical composition and potential biological activities of the plant extracts might beexploited in the pharmaceuticalindustries as medicines.

ACKNOWLEDGEMENT

The authors would like to thanks Department of Botany, Sunderrao Solanke Mahavidyalaya, Majalgaon, and Amruteshwar Arts, Commerce and Science College, Vinzar, Pune for providing library and internet facilities for the literature survey.

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International E-Conference on Life Sciences, Technology and Management
In Association with International Journal of Scientific Research in Science and Technology
Volume 9 | Issue 9 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Soybean Response to Biological and Chemical Fertilizers

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ABSTRACT

The field trial was conducted to investigate the effect of organic and inorganic Fertilizers on the growth of leguminous crop viz., soybean. The experiment was carried out in a Randomized complete Block Design (RCBD) and field trials were carried out in triplicates. The variety Mahabeej was used for trial. The fertilizers treatments comprised of five type's viz., Urea, 18-18, 12-32-16, FYM, poultry manures, Compost manures and control crop was not provided any fertilizer treatment. The result showed that poultry manures+18-18 and FYM +18-18 fertilizers had significant effect on Biochemical analysis (Crude Protein, Crude Fat, Crude Fiber, Nitrogen free extract, Acid Insoluble Ash and Total Carbohydrates,) at 30, 60, and 90 days after sowing. FYM+18-18 fertilizers had significant effect on Biochemical Analysis in comparison with untreated crop.

Keywords: Poultry Manures, Compost Manures, Yield Production, Inorganic Fertilizers, Control crop.

I. INTRODUCTION

Soybean (Glycine max L.) is considered as a wonder crop of 21st century which is the top oil seed in the world production. It is an important oil seed crop in addition to source of food, feed and nutrition (Imkongtoshi and Gohain, 2009). Organic fertilizers not only improve the soil physical and biological properties, also improved the efficacy of chemical fertilizers (Alam et al., 2010). Application of organic manure not only produced the highest and sustainable crop yield, but also improves the soil fertility and productivity (Sanwal et al., 2007). FYM provides essential macro and micro-nutrients, improves soil physical, chemical and biological environment by which it increases crop yield (Sangashetty, 2006). Nitrogen should be applied to a crop at times that avoids periods of significant loss and provide adequate N when needed. Soybean nitrogen (N) requirements are met in a complex manner, as this crop is capable of utilizing both soil N (mostly in the form of nitrate) and atmospheric N (Through symbiotic nitrogen fixation) (Vera et al., 2002). Manure is a readily available organic source of essential plant nutrients. It is used primarily as a source of plant nutrients (Mullins et al., 2002). Soybean being a highly nutrient-exhaustive legume requires higher amounts of nutrients, particularly P and K for its optimum production (Hasan, 1994). While application of

nitrogen fertilizer is not common for soybean crop, it is believed that the ability of soybean plant for fixing air N2 to meet nitrogen requirements and maximum yield production is not enough (Wesley et al., 1998).

II. MATERIAL AND METHODS

The present work entitled "Effect of Various Fertilizers on the Growth and Yield of Soybean and Jowar" was carried out, during three consecutive Rabi seasons in the year 2016 to 2018 at the Department of Botany Sawarkar Mahavidyalaya, Beed. The experimental plots were laid out in a Randomized Complete Block Design (RCBD). Two plants were selected one from leguminous (Soybean) and other from non-Leguminous (Jowar). The Square plots were allocated with three organic and other inorganic Fertilizers viz., Application of farmyard manure (FYM= 10t/ha) Application of Poultry manure (PM), Application of Compost manure (CM= 2.5ton/ha) and Applications of recommended doses of chemical fertilizers i.e. Urea: 46% N (N= 180kg/ha), phosphorus and potassium. The experimental crop seeds were sown using single row hand drill on well prepared seeds bedthe quantity of FYM and PM to be added was calculated according to Rashid and Memo (2001). Dose of phosphate (P), nitrogen and Urea in the respective plots before sowing and remaining at the time sowing was applied. All other agronomic practices were kept normal and uniform. These fertilizers treatments were designated as F1 to F14 respectively.

The *Soybean* variety (**Mahabeej DS 228**) was cultivated for three seasons to observe the effects of different organic and inorganic fertilizers. The effects of FYM, poultry manure, chicken manure, compost manure and inorganic fertilizers viz., nitrogen (N), phosphorus (P) and potassium (K) on the treated and control plants were studied. The chemical composition of *soybean* calculated for three seasons has been given in the (Table No.20, 21and22). In the year (2016) application of organic and inorganic fertilizers significantly showed an increase in the dry matter content, crude protein and crude fibers, total ash and acid insoluble ash over the untreated crop.

III. RESULT AND DISCUSSION

Table No. 20: Effect of organic and inorganic fertilizers on Control and Treated *Soybean* crop (2016)

Sr. No.	Parameter	Treatments		Difference
		Control	Treated	
1	DM	16.15	17.30	1.15%
2	CP	29.60	31.85	2.25%
3	Cfat	3.50	3.90	0.40%
4	CF	28.50	30.30	1.8%
5	Total Ash	15.10	15.20	0.10%
6	AIA	6.30	6.80	0.50%
7	NFE	23.30	18.75	4.55%
8	TC	51.80	49.05	2.72%

In the first year (2016), the dry matter (DM) in treated *soybean* was 17.30% while in control it was 16.15%. The crude protein content of control and treated was 29.60 and 31.85 respectively. Crude fat (Cfat) concentration in control and treated was 3.50and 3.90. The crude fibre (CF) from treated and control 30.30 and 28.50.The total ash was 15.20 and 15.10 respectively. Acid insoluble ash was calculated and was 6.80 and 6.30 from treated and control. Nitrogen free extract was calculated and that was 18.75 from treated and 23.30 from control. The total carbohydrate measured and was 49.05 and 51.80 from treated and control plant respectively.

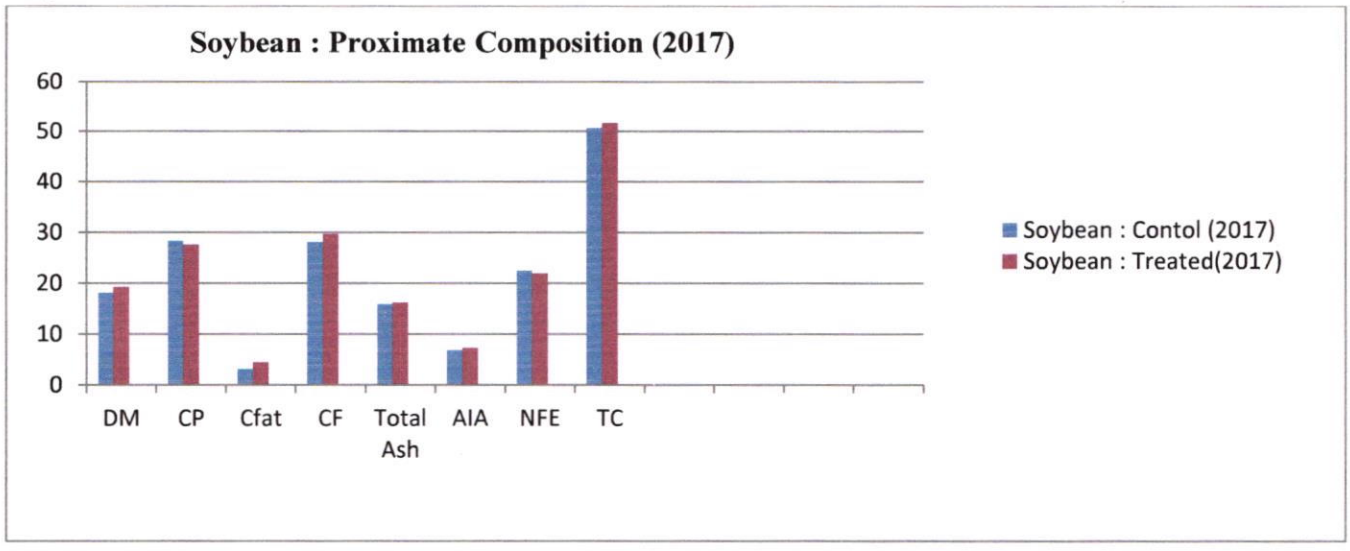
Table No. 21: Effect of organic and inorganic fertilizers on Control and Treated *Soybean* crop (2017)

Sr. No.	Parameter	Treatments		Difference
		Control	Treated	
1	**DM**	18.10	19.30	1.2%
2	**CP**	28.30	27.60	0.7%
3	**Cfat**	3.20	4.50	1.3%
4	**CF**	28.10	29.70	1.6%
5	**Total Ash**	15.90	16.20	0.3%
6	**AIA**	6.90	7.30	0.4%
7	**NFE**	22.50	22.00	0.50%
8	**TC**	50.60	51.70	1.1%

During the second year i.e.2017 the contents of dry matter, crude protein, crude fat, crude fibre, total ash, acid insoluble ash, nitrogen free extract, total carbohydrate from treated crops were 19.30, 27.60, 4.50, 29.70, 16.20, 7.30, 22.00 and 51.70 respectively whereas from the control that were 18.10, 28.30, 5.20, 28.10, 15.90, 6.90, 22.50 and 50.60 respectively. In the last year (2018) the dry matter, crude protein, crude fat, crude fibre, total ash, acid insoluble ash, nitrogen free extract and total carbohydrate from treated *soybean* were 22.50, 29.30, 6.40, 30.90, 15.40, 7.20, 18.00 and 30.90 respectively. On the other hand from control *soybean* were 20.60, 27.80, 5.80, 28.70, 14.70, 5.80, 23.00 and 51.70 respectively.

The results obtained by Rajput *et al.,* (2018) on proximate composition from legume and non-legume fodder crops were however higher than the results obtained during present work. The results recorded from present work for the yields are in agreement with the results obtained by Patil and Mungikar (1991). The variations seen in the values of control crops were due to the seasonal changes. The results obtained indicated that the dry matter yield and nutrient elements showed an increase owing to utilization of poultry manure, chicken manure, compost manure

Graph:



IV. CONCLUSION

The response of soybean crop to various treatments was evaluated with growth attributes and yield attributes nutrient contents of soil before sowing and after harvest. The salient findings of this investigation are enumerated as under. The Biochemical composition of soybean concluded for three years, the dry matter yield of soybean crop was comparatively high (22.50%) in 2018 as compared to the dry matter production in the years 2016, 2017 which was (17.30%) (19.30%) respectively. 13. The crude protein was recorded maximum in the year 2018 i.e. (29.30%) whereas it was (27.60%) and (31.85%) during the 2017 and 2016 respectively in soybean crop. 14. Total carbohydrates was recorded maximum in the year 2017 i.e. (51.70%) whereas it was (30.90%) (49.05%) during the 2018 and 2016 respectively. 15. From the present work it may be concluded that the legume and non-legume fodder plants with more nutritive significance and increased productivity can be practiced in this Marathwada region.

V. ACKNOWLEDGEMENT

The authors are immensely thankful to the management and the Principal swa. Sawarkar Mahavidyalaya, Beed for allowing us for completing the undertaken research work in the authorized research laboratory and providing the facilities during conducting research work. I am also grateful to the Principal of SunderraoSolanke College, Majalgaon, Beed for constant encouragement in carrying out this research work.

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