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Assessment of Biochemical Traits and Minerals Status of Oat (*Avena sativa* L.) Genotypes

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ABSTRACT: The present investigation was carried out during the Rabi season in *Avena sativa* L. in 2020-21 at coordinated Livestock Farm, All India Coordinated Research Project on Forage Crop (AICRP), Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. This study aimed to investigate the biochemical traits and minerals composition of thirty genotypes. Results showed significant ($p<0.05$) differences in biochemical and minerals compositions among studied genotypes. Oat grain constituents ranged between 8.93-13.43% protein, 4.21-6.90% fat, 2.81-5.97% Ash, 57.50-66.85% total carbohydrate and 8.29-10.55% crude fiber. Iron, zinc, manganese, potassium and sodium contents were 2.38-4.65mg/100g, 1.30-3.69mg/100g, 2.69-4.49mg/100g, 234.88-347.22mg/100g and 0.85-1.85mg/100g respectively. These results could be useful for improving value-additional of oat food products.

Keywords: Oat, biochemical parameters, minerals composition, etc.

INTRODUCTION

Oat (*Avena sativa* L.) is a cool season, temperate crop, annual having both food and feed values. It belongs to family poaceae and ranks sixth in production among all cereal crops next to wheat, maize, rice, sorghum and barley in the world. It is an economically significant crop used as both purpose fodder for animals and processed oatmeal for human consumption. Oat has been globally known as relevant for a wide range of applications namely in medicine, pharmacology and food industries commercially.

Oat grain are recognized for rich nutritional profile and well known cereal food for humans and feed for livestock. It is also stated that oat leafs has various medicinal properties, traditionally it is known to cure the menstrual imbalance ailment and treatment of osteoporosis and urinary tract infections (Duke, 2002). They contain nutrients, digestible carbohydrates, protein and dietary fiber fractions required for a balanced human diet. Earlier, oats were mainly used as feed for animals, but current findings had pointed out new possibilities for the health-promoting properties of oats and oat products (Brennan and Cleary 2005).

Recently, oat became very popular due to their health benefits. It has a well-balanced nutritional composition. It is the cereal having rich protein content (12-24%). Oat is a good source of essential vitamins such as thiamin, folic acid, biotin, pantothenic acid and vitamin E. It comprises of nutrients like copper, zinc, selenium, iron, manganese and magnesium. Oat contains high percentage of oat lipid specially unsaturated fatty acid, minerals, vitamins and phytochemicals (Head *et al*., 2010). It is also having some medicinal values like regulating gastrointestinal function, may reduce asthma risk in children, reduces blood cholesterol, reduces risk of type 2 diabetes, increases appetite control and it boosts the immune system of the body and helps in preventing heart diseases. It regulates blood sugar level, has properties like diuretic and anti-inflammatory, and helps to reduce the chances of hormone related cancers significantly. Oats are used in cosmetics industries as to smoothen the skin. Oats are a major constituent of infant foods due to their high nutritional composition, lack of allergenicity, palatable flavour, good shelf-life, stability and low cost value. Food made of oats include oatmeal, oat bran, oat flour and oat cake which are mainly used for breakfast cereals. Porridge, bread, biscuits, infant food, muesli and granola bars are a few examples of food products prepared from oats. The objectives of this study was assessment of the biochemical composition and minerals content in oat genotypes. These results could be useful for improving value-additional oat food products and more effective and productive livestock, medicine and food industries. Also, identifying, promoting use and breeding of oat genotypes with maximum content of the nutritional composition is the best and socially accepted approach for improving cereal nutritional status.

MATERIAL AND METHODS

An experiment was conducted to the assessment of biochemical traits and minerals status of oat (*Avena sativa* L.) genotypes during *Rabi* season of the year 2020-21 at the coordinated Livestock Farm, All India Coordinated Research Project on Forage Crop (AICRP), Department of Agronomy, JNKVV, Jabalpur. The research evaluated performance of thirty genotypes. Estimation of biochemical parameters was done in the laboratory of the Department of Plant Physiology, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh.

Sample preparation. The oat grains were sorted and cleaned manually to remove foreign materials, cracked and broken seeds and then dehulled using local wood-made pestle and mortar to remove the husk before use in analysis. The grains were then crushed using an electric grinder to pass through a 0.05 mm sieve, packed in polyethylene bags, and stored at 4^0C until further analysis.

Biochemical composition of oats genotypes. Different biochemical traits of samples were analyzed *i.e*. protein content, fat, fiber, total carbohydrate, crude fiber and ash. The protein content was estimated by micro-kjeldhal method (AOAC, 1965) and the fat content in the sample was estimated by Pelican Equipment Socs Plus based on principle of Soxhlet's extraction method as described in AOAC (1980). Total carbohydrates in the samples were estimated by the method as described by Sadasivam and Manickam (1992). The ash content in the seed sample was estimated according to AOAC (1980).

Minerals status of oat genotypes. Atomic Absorption Spectrophotometry (AAS) was used to determine the minerals like Manganese (Mn), Zinc (Zn) and Iron (Fe) and Flame photometer was used to determine sodium (Na) and potassium (K).

RESULTS AND DISCUSSION

1) Protein (%)

Protein rich foods is vital to life and is needs for proper growth and maintenance of human body. The basic structure of protein is a chain of amino acids. It is essential to muscle growth, aids bone health improves metabolism helps in tissue repair, and can reduce blood pressure. The present research (Table 1 and Fig. 1) showed that higher protein % was registered in genotypes G_{15}: JMO-272 (13.43%), G_{18}: JMO-316 (13.29%), G_{19}: JMO-317 (13.16%), G_{27}: JMO-42 (13.12%) and G_{25}: JMO-211 (13.05%) however they showed significant difference among them. Lowest was registered in G_{30}: MJO15-5 (8.93%). Khakim *et al.* (1998) revealed that the grain yield was positively correlated with the total protein yield, while the grain yield was negatively correlated with grain protein content. The oil content also increased seed protein and lysine content significantly. The rapida variety has higher protein content of 14.2% as compared to 7.8% of the commercial sample (Rao *et al*., 1974). The protein content found in the oat was 12.62% (Syed *et al*., 2020). Saleem *et al*. (2015) noted that maximum protein was recorded in variety Sargodha-2011 (10.38%) followed by Avon (9.09%) which were lower than CV-SRCP X 80 Ab 2806. Peterson *et al.* (2005) and Yanming *et al.* (2006) indicated that genetic variation was important for protein content.

2) Fat (%)

Oat genotypes usually include more fat than other cereal grains (Zhou *et al.*, 1999). There is a high nutritional potential of oat because of the valuable fatty acid composition of the fat. Fat helps the body absorb vitamin A, vitamin D and vitamin E. These vitamins are fat soluble, which means they can only be absorbed with the help of fat content. In our finding genotypes G_{10}: JMO-261(6.90%), G_{19}: JMO-317 (6.54%) and G_7: JMO-239 (6.33%) influenced the higher fat % still they varied significantly among them. Significant lowest value was found in G_{11}: JMO-263 (4.21%). The grain yield was positively correlated with the oil content of grain (Khakim *et al*., 1998). The fat percentage in spring oats range from 3.8 to 8.5% with a mean of 5.6% fat, while the winter oats varied from 6.8 to 9.8% with a mean of 8.2%, our results was also similar as the finding of Brown *et al*. (1966).

3) Total Carbohydrate (%)

The high content of total carbohydrate are a vital part of a healthy diet. They are providing energy, regulation of blood glucose and breakdown of fatty acids. In present investigation, the data revealed that (Table 1 and Fig. 1) genotypes G_{18}: JMO-316 (66.85%), G_{19}: JMO-317 (66.48%) and G_{10}: JMO-261 (66.16%) verified significantly maximum total carbohydrate contents over rest of the genotypes. While G_{30}: MJO15-5 (57.50%) noted the minimum value. The higher carbohydrate content in grains was attributed to the higher photosynthetic rate and subsequent mobilization of assimilates in economic parts. Accumulation of organic solutes, like carbohydrates, is a common response of plants exposed to stress conditions as a defense mechanism (Sadiq *et al.,* 2017). Result of investigation are also similar as reported by Kudake *et al*. (2017) and Syed *et al.* (2020).

Table 1: A various biochemical parameters of Rabi oat genotypes during year 2020-2021.

Genotypes	Protein (%)	Fat (%)	Total Carbohydrate (%)	Crude fiber (%)	Ash (%)	Minerals (mg/100 g)				
						Fe	Zn	Mn	K	Na
G_1:JO-1(check)	10.58	5.01	62.18	8.29	3.84	2.37	1.35	2.85	261.63	0.90
G_2: JMO-207	9.93	5.23	62.24	9.48	3.60	2.53	1.43	2.69	257.55	1.20
G_3: JMO-214	10.53	6.01	59.76	9.98	4.21	2.74	3.54	4.32	316.71	1.60
G_4:JMO-215	9.23	5.65	61.34	10.28	4.70	4.49	1.42	3.15	344.66	1.82
G_5: JMO-217	9.53	4.55	61.65	9.73	3.46	2.47	1.36	2.81	319.66	1.46
G_6: JMO-234	10.37	5.78	63.31	9.50	4.38	3.37	3.53	3.89	298.16	1.59
G_7: JMO-239	10.90	6.33	64.87	9.67	4.14	3.22	1.85	2.72	314.82	1.09
G_8 :JMO-240	12.47	5.87	65.22	8.52	3.18	2.55	1.73	2.80	305.67	1.21
G_9:JMO-257	12.66	5.33	65.36	8.63	3.77	2.47	2.83	3.64	320.24	0.93
G_{10}:JMO-261	10.60	6.90	66.16	10.55	5.04	4.65	3.51	4.43	358.85	1.83
G_{11}:JMO-263	11.30	4.21	62.95	9.41	3.74	2.60	2.63	4.28	264.59	1.26
G_{12}:JMO-264	12.66	4.22	62.09	8.65	3.55	3.35	2.81	3.64	339.71	1.22
G_{13}:JMO-270	12.00	4.31	59.51	8.58	3.84	2.63	2.39	3.13	269.67	1.12
G_{14}:JMO-271	12.71	5.21	64.03	8.52	3.70	4.13	2.13	3.36	288.49	1.51
G_{15}:JMO-272	13.43	5.99	63.50	10.47	4.01	4.57	1.55	4.17	333.10	1.85
G_{16};JMO-303	11.10	6.12	61.07	10.28	5.51	4.50	3.69	4.49	312.29	1.79
G_{17}:JMO-304	11.40	5.39	63.28	9.48	3.58	2.51	3.22	3.33	277.99	1.47
G_{18}:JMO-316	13.29	6.05	66.85	10.17	5.58	4.62	3.57	4.38	347.22	1.81
G_{19}:JMO-317	13.16	6.54	66.48	10.79	5.97	3.79	3.24	3.14	300.34	1.27
G_{20}: Kent (check)	10.10	5.42	59.55	8.75	3.00	2.38	1.46	3.56	234.88	0.87
G_{21}:JMO-401	9.73	5.56	60.06	9.46	4.40	2.48	1.77	3.76	290.42	1.19
G_{22}JMO-407	12.48	5.07	59.73	9.04	4.21	3.35	1.82	3.97	242.20	1.16
G_{23}:JMO-422	12.97	5.64	61.44	8.95	5.11	2.56	2.25	3.81	267.41	1.00
G_{24}:JMO-209	11.63	5.55	60.13	9.68	4.12	2.41	3.03	3.73	325.75	1.45
G_{25}:JMO-211	13.05	5.50	61.92	8.87	3.44	2.59	2.65	2.80	321.55	1.00
G_{26}:JMO-46	10.73	4.85	60.00	9.55	3.59	2.44	2.60	3.72	269.67	1.40
G_{27}:JMO-42	13.12	6.04	65.18	10.11	5.00	3.88	2.78	4.20	328.96	1.84
G_{28}:MJO15-1	9.17	5.18	58.87	9.06	3.13	2.51	2.24	2.84	237.75	1.06
G_{29}:MJO15-3	9.33	5.42	58.81	9.73	3.12	2.57	1.30	3.32	276.71	0.85
G_{30}:MJO15-5	8.93	5.04	57.50	9.67	2.81	2.40	1.41	2.87	250.21	1.10
Mean	**11.30**	**5.47**	**62.17**	**9.46**	**4.06**	**3.10**	**2.37**	**3.53**	**295.90**	**1.33**
SEm±	**0.42879**	**0.1802**	**2.00941**	**0.398937**	**0.2635**	**0.24322**	**0.2109**	**0.2573**	**23.834**	**0.11558**
CD at 5%	**1.21384**	**0.5103**	**5.68837**	**1.12933**	**0.7460**	**0.68854**	**0.59705**	**0.7285**	**67.471**	**0.32719**

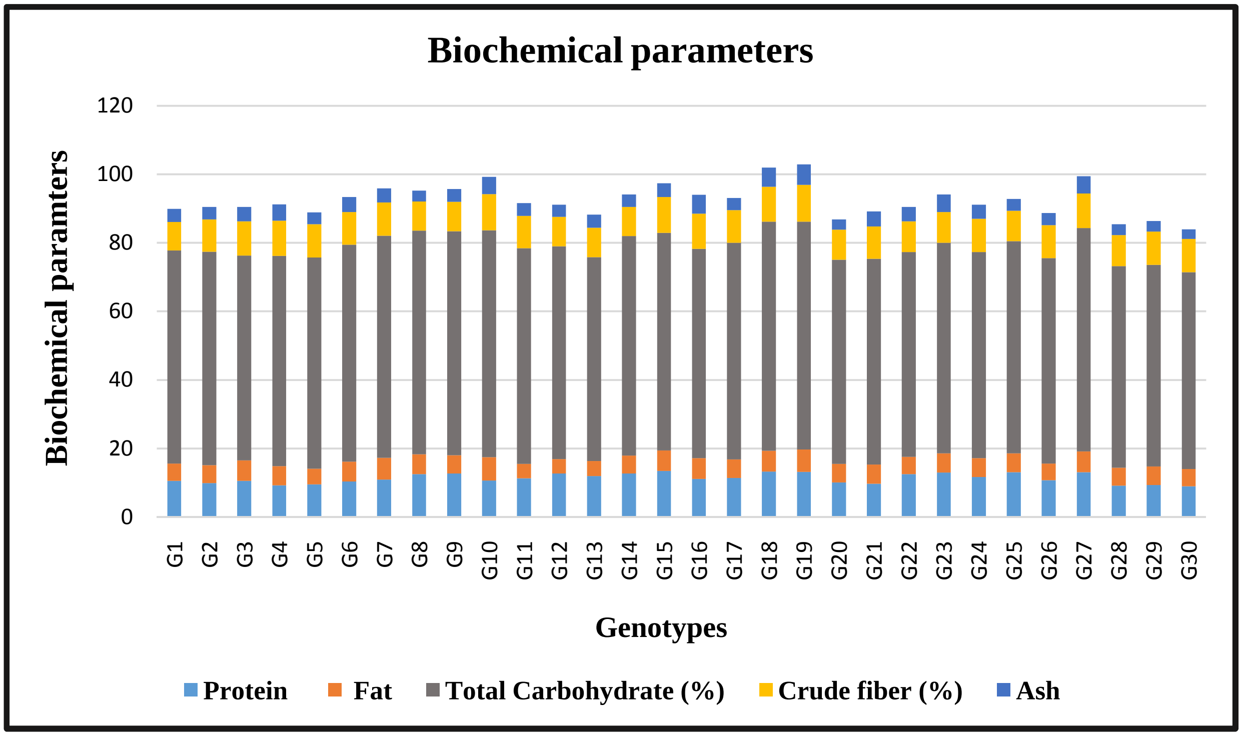

Fig. 1. A various biochemical parameters of Rabi oat genotypes during year 2020- 2021.

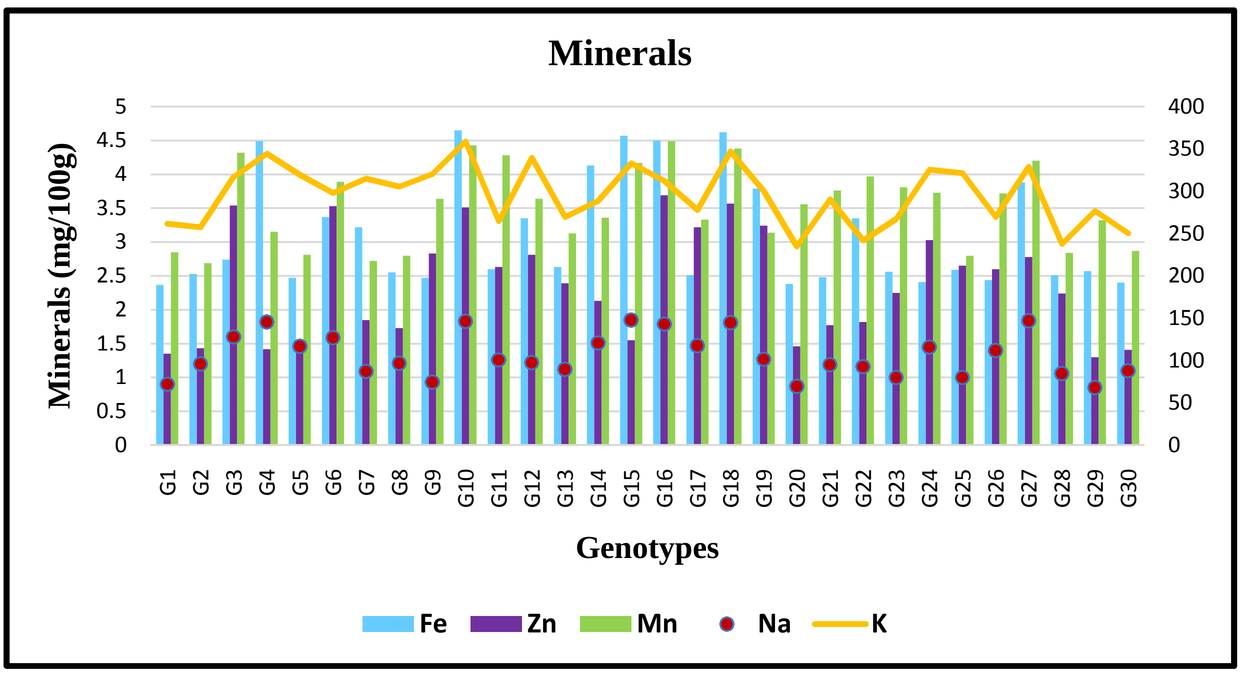

Fig. 2. A variation in minerals (mg/100g) of Rabi oat genotypes during year 2020- 2021.

4) Crude fiber (%)

The maximum of crude fiber content in oat is soluble, mostly a fiber called beta glucan. Oat crop also provide insoluble fiber, including hemicellulose, cellulose and lignin. Beta glucan has shown enhanced antimicrobial (stops the growth of microorganism), anti-diabetic, anticancer, and anti-hypercholesterolemia (controls cholesterol levels) properties in countless clinical investigations. It significantly reduce the risk of cholesterol scores and reduced risk for diabetes and cardiovascular disease. The genotype G_{19}: JMO-317 (10.79%), G_{10}: JMO-261 (10.55%) and G_{15}: JMO-272

(10.47%) indicated the significantly higher % of the fiber over the remaining genotypes still they varied significantly between them. The genotype G_1: JO-check (8.29%) registered the minimum value. Epidemiological suggestion that a high fiber diet may help to reduce the occurrence of certain chronic non-communicable diseases like coronary heart disease, colon cancer, diabetes, obesity, high blood pressure, and several gastrointestinal problems (Pinto-Sanchez *et al.*, 2017; Rasane *et al*., 2013).

5) Ash (%)

Ash content can affect different characteristics of food including nutritional and physiochemical properties. Ash determination of grain sample is part of the biochemical analysis essential for the identify the total filler content it means ensures the safety of foods, making sure there are no toxic minerals present. The genotype G_{19}: JMO-317 (5.97%) expressively superseded remaining genotypes G_{16}: JMO-303(5.51%) which was at par and the minimum was recorded in G_{30}: MJ015-5 (2.81%). Syed *et al*. (2020) noted that the content of ash found in the oat was about 1.97 per cent.

6) Minerals (mg/100g)

The mineral contents of the oat genotypes iron, zinc, manganese, potassium, and sodium showed significant ($p < 0.05$) variation among the oat genotypes. Minerals are inorganic elements that have essential metabolic functions which cannot be produced by living organisms. Trace minerals are less than 1 % of the minerals in our body but are essential for our life (Gordon and Hampl 2007). Minerals play a major role in structural functions involving soft tissues and the skeleton, as well as regulatory functions such as oxygen transport, neuromuscular transmission, blood clotting and enzymatic activates (NRC, 1989). Most of the physiological functions of minerals are closely associated to their role in enzyme activity.

In Minerals, the study showed that among genotypes significantly maximum iron (Fe) was found in genotypes G_{10}: JMO-261 (4.65mg/100g) and G_{18}: JMO-316 (4.62 mg/100g) and significant lowest value was found in G_1: JO-check (2.37 mg/100g). Ozcan *et al.* (2017) reported that the iron contents of many different oat varieties, ranging from 3.0 to 8.1 mg/100 g. These results of present investigation are also in agreement with those of Chappell *et al*. (2017) and Youssef *et al.* (2016). Iron as a components of hemoglobin, a protein responsible for transporting oxygen in the blood. The genotypes G_{16}: JMO-303 (3.69 mg/100g), G_{18}: JMO-316 (3.57 mg/100g) and G_{10}: JMO-261 (3.51 mg/100g) possessed the maximum Zn content though they differed significantly among them. Significantly the minimum value was found in G_{29}: MJO15-3 (1.30 mg/100g). Ozcan *et al.* (2017) observed that zinc contents of oats ranged between 1.5 mg/100 g and 3.8 mg/100 g, which is in close agreement with our finding. However, our result is slightly lower than the values reported by Sangwan *et al.* (2014) (3.3–4.5 mg/100 g). The variation could be related to a genetic variance and agronomic management practices applied during production. The Zn participates in many chemical reactions and it is also essential for immune function, wound healing, blood clotting, and thyroid function.

The data indicated that, the higher manganese (Mn) content was registered in genotypes G_{16}: JMO-303 (4.49 mg/100g) at par with G_{10}: JMO-261 (4.43 mg/100g) and G_{18}: JMO- 316 (4.38 mg/100g) and lowest in G_7: JMO-239 (2.72 mg/100g). Naturally, Mn found in high amounts in whole grains, this trace mineral is important for growth, development and metabolism. Potassium is an essential mineral for maintaining total body fluid, cellular function and electrolyte balance. Table 1 and Fig. 2 shows the genotypes G_{10}: JMO-261 (358.85 mg/100g), G_{18}: JMO-316 (347.22 mg/100g) and G_{12}: JMO-264 (339.71 mg/100g) showed the significantly higher K content as compared to all other genotypes though they differed significantly between them. The minimum was registered in G_{20}: Kent (check) (234.88 mg/100g). Also, higher sodium (Na) content was recorded in genotypes G_{15}: JMO-272 (1.85 mg/100g) at par with G_{27}: JMO-42 (1.84 mg/100g), G_{10}: JMO-261 (1.83 mg/100g) and lowest was noted in G_{29}: MJ015-3 (0.85 mg/100g). Small amount of sodium to conduct nerve impulses, contract and relax muscles and maintain balance of water and minerals.

CONCLUSION

In conclusions, cultivated oat genotypes grown together in the normal environmental conditions showed significant genetic variation in the nutritional content of the oat grain, including protein, fat, crude fiber, carbohydrate, ash and minerals (Fe, Zn, Mn, K, Na). The biochemical analysis indicated that among genotypes recorded the maximum protein G_{15} (13.43 %), total carbohydrate G_{18} (66.85 %), fat G_{10} (6.90 %), crude fiber G_{19} (10.79%), ash G_{19} (5.97%) in all the genotypes. In Minerals, higher value of iron G_{10} (4.65 mg/100g), zinc G_{16} (3.69 mg/100g), manganese G_{16} (4.49 mg/100g), potassium G_{10} (358.85 mg/100g), sodium G_{15} (1.85 mg/100g) in all oat genotypes. The present research was designed to explore the oat as economical raw material for nutraceutical, food and animal feed industry. The developed oat genotypes need to be considered for further expansion and commercialization in other regions of the country or other developing countries to contribute for ensuring food and nutritional security.

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