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Effects of Age and Genotype on Vitamin C (*Ascorbic acid*) and Fiber Contents in *Brassica napus*

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Authors' contributions

The authorship of this work was carried out in partnership. Author MM carried out the experimental trials in the field, writing of the manuscript and interpretation of data. Author LT helped in performing the statistical analysis and planning for the execution of research, guided the interpretation process and proof read the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Rape (*Brassica napus*) is one of the major vegetables grown in Zambia and is an important source of nutrients in human diet. Vitamin C is an essential antioxidant molecule while fiber on the other hand plays a key role in mitigating constipation. However, the effects of rape genotype and the vegetative maturity (age) on nutrient content on vitamin C and fiber is not clearly understood. The objectives of the study were therefore, to; i) to evaluate the effects of age on vitamin C and fiber nutrient content in rape leaves and ii) evaluate the genotypic effect of rape leaves on vitamin C and fiber contents. The experiment was conducted Munachoonga farm, in Monze district, Zambia (16 ^{o} 16’ 45’’ S; 27^{o} 28’25’’ E) during the 2020/ 2021 cropping season. The experiment was laid as a split plot design with three replications. Soil fertilizer amendments were the main plot while variety (genotype) as a subplot. Data was collected at 6 and 10 weeks old after transplanting. However, for each treatment, a representative sample was collected by thoroughly mixing all three associated reps and obtaining a representative leaf sample giving 18 experimental units. The dried samples were taken to the University of Zambia Lab for analysis. The results showed that the mean fiber content was higher at week 10 than week 6 ($P< 0.001$), while vitamin C was higher at week 6 than week 10 ($P= 0.05$). Implying that younger leaves are likely to supply a higher content of vitamin C than older leaves. The lesser content of fiber at younger stage of rape explains why most

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consumers found rape more palatable at a younger stage. It was also revealed that vitamin C and fiber nutrient contents did not depend on the type of genotype. Furthermore, a study to evaluate the precise effects of fertilizer amendment on vitamin C and fiber contents should be undertaken.

Keywords: Rape; nutrient contents; week; palatable.

1. INTRODUCTION

Rape (*Brassica napus*) is one of the major vegetables grown in Africa. It is mainly served and eaten with thick porridge (made from maize flour) and is a common delicacy in the region [1]. In Zambia, rape is grown all year round, although high production is realized in a cool season [2,3]. The optimum harvest period ranges from four to six weeks after transplanting beyond which rape is considered less palatable [3]. A well-managed rape crop approximately yields 20 tons per hactare and in addition, rich fertile soils are required to achieve high productivity [4]. However, most soils in Zambia range from clay to sandy soils whose nutrients may not be adequately due to depletion of soil nutrients as a result of all year round production of rape, leaching and soil erosion. In this regard, several plant and animal based fertilizer combinations have been used to replenish depleted soil nutrients [3,5].

Most of the rape produced in Zambia is for domestic consumption at family level and for sale in fresh markets locally, for generation of income. In addition to generating income and use as relish, rape is an important source of nutrients. In this study, we shall prioritize vitamin C and dietary fiber contents. In a nut shell, fruit and vegetables are good sources of vitamin C, and ~90% of the daily intake in the general population comes from these sources [6]. Vitamin C is an essential antioxidant molecule in plant and animal metabolism and also functioning as a co-factor in many enzymes [7]. It helps in the synthesis and metabolism of tyrosine, folic acid and tryptophan, hydroxylation of glycine, proline, lysine carnitine and catecholamine, and facilitate the conversion of cholesterol into bile acid and hence lower blood cholesterol levels [8]. Additionally, its historical role in the prevention of scurvy is well known [9]. It should be noted that nutrients such as vitamin C cannot be produced by the body and hence it has to be taken in [10]. Fiber on the other hand plays a key role in digestion of food and mitigating other health complicated problems such as constipation [11]. Though fiber is a type of carbohydrate, it cannot be digested by the human body. This implies that it cannot be broken down into sugar molecules but instead, it passes through the body undigested. It helps to regulate the body's use of sugars, helping to keep hunger and blood sugar in check [11]. However, the effects of rape genotype and the vegetative maturity (age) nutrient content in rape is not clearly understood. This paper builds up on an earlier study on quantitative trait responses in rape by Mayuniyuni and Tembo [2]. In this study, we focused on the assessment of selected nutrient responses across several fertilizer amendments utilized for crop production in Zambia.

The objectives of the study were therefore, to i) evaluate the effect of genotypic age on vitamin C and fiber nutrient contents in rape leaves and ii) evaluate the effect of rape genotype on vitamin C and fiber contents.

2. MATERIALS AND METHODS

2.1 Experimental Site and Land Preparation

The experiment was conducted at Munachoonga farm in Monze district, Zambia (16 ^{o} 16' 45'' S, 27 ^{o} 28'25'' E) during the 2020/ 2021 cropping season as by Mayuniyuni and Tembo [2]. The experimental site was chosen near an artificially dug well to ensure the crops were free from water stress. The land was initially prepared for cultivation by removing the bush using an axe and a slasher. This was done in order to remove weeds, pests and make it easy to cultivate. Later on, primary cultivation (tillage) was done by digging the soil up to approximately 30 cm deep using a pick. Secondary tillage was then carried out using a hoe to get a fine tilth for easy penetration of crop roots in the soil. The standard cultural practices such as weeding and pest control were done appropriately.

2.2 Management and Conduct of Experiments

Three popular and farmer preferred genotypes English Giant (ENG), Hobson (HOB) and

Rampart (RAM) obtained from Starke Ayres (PVT) LTD Gauteng South Africa, East African Seed Company in Kenya and African Seed Company in Zambia respectively were used in this study. Prior to evaluation, genotypes were initially planted in the nursery before they were transplanted to the experimental plots at approximately 30 days after germination. The experiment was laid as a split plot design with three replications. Fertilizer amendments were the main plot and genotype was used as a subplot. Each genotype in the main plot was planted to one row plot of 4 m long with 30 cm spacing within and between rows. The rape genotypes were evaluated in animal product based fertilizer amendments including non-nutrient applied (NNA)] and Artificial fertilizer. The animal product based amendments were: 1) raw cow-dung and cow-dung ash (RCD+CDA), 2) raw cow-dung (RCD), 3) cow-dung ash (CDA) and 4) combination of artificial fertilizer, raw cow-dung and cow-dung ash (AF+RCD+CDA).

2.3 Quality Data Collection

Data pertaining to the nutrient content in experimental rape vegetables were collected through the lab tests on the harvested leaves. The nutrient test (analysis) was done at University of Zambia, School of Agricultural Sciences (15°23'36''S and 28°20'10''E). The vegetable samples were submitted in two sets, the first one being harvested at 6 weeks after transplanting while the second set was harvested at the 10^{th} week. For each treatment, a representative of the three reps was collected by thoroughly mixing and obtaining an appropriate leaf sample size giving a downsized total of 18 experimental units. Six for each genotype. The 18 freshly harvested samples were sun dried, for three days, tied and carefully labelled indicating the genotypes ENG, HOB and RAM rape grown under six different soil amendments. Evaluation of vitamin C and Fiber, were determined as by AOAC [12].

2.4 Data Analysis

Assessment of mean nutrient content across genotypes and fertilizer amendments for fiber and vitamin C between rape ages 6 and 10 weeks were computed using a paired T-test, two tailed distribution. The genotypic mean nutrient content differences across fertilizer amendments for fiber and vitamin C were explored using the standard error of the mean. The analysis of variance (ANOVA) using a split plot design was not employed as the associated rep treatment was collected as a single representative sample. All the data analysis was carried out using excel, Microsoft office 2013.

3. RESULTS

3.1 Effects of Nutrient Content on Age in Rape

The results showed that the mean fiber content across soil amendment and genotypes was higher at 10 weeks of age compared to 6 weeks ($P < 0.001$). On the other hand, it was vice versa with vitamin C ($P= 0.05$) (Table 1).

3.2 Effects of Genotype on Nutrient Content in Rape across Weeks and Fertiliser Amendments

The genotypic nutrient results across age (week 6 and week 10) and soil amendment are presented in Table 2 and 3. Genotypic comparisons with regards to fiber and vitamin C nutrients showed no significant difference among genotypes. The standard error bars of fiber and vitamin C overlapped each other among the three genotypes, ENG, HOB and RAM (Table 2 and 3), implying that the nutrient content (vitamin C and fiber) was not influenced by rape genotype.

Table 1. T- Test comparisons of mean nutritive performance at 6 and 10 weeks across genotypes and soil amendments

Parameter	Mean-X	Mean-Y	Difference	P- value
Fiber (%)	8.65	13.59	4.94	< 0.001
Vitamin C (mg/Kg)	328.00	223.35	104.65	0.05

X-mean value of measured nutrient across soil amendments and genotypes at 6 weeks after transplanting
Y-mean value of measured nutrient across soil amendments and genotypes at 10 weeks after transplanting

Table 2. Evaluation of genotypic mean fiber (%) performance in rape across fertilizer amendments and age of rape

AGE	FM	ENG	HOB	RAM
A	AF	8.8	9.14	9.93
A	AF+RCD+CDA	5.38	6.58	7.76
A	CDA	9.21	9.97	10.33
A	NNA	8.19	7.94	10.89
A	RCD	9.9	9.87	10.37
A	RCD+CDA	8.16	6.65	6.55
B	AF	13.31	13.14	14.56
B	AF+RCD+CDA	15.93	13.47	13.86
B	CDA	13.4	11.36	16.95
B	NNA	11.4	15.62	15.04
B	RCD	12.75	11.85	12.71
B	RCD+CDA	14.15	13.15	11.93
	Mean	10.88	10.73	11.74
	Std dev.	3.09	2.86	3.05
	+/-SE	**0.89**	**0.83**	**0.88**

A-6 weeks after transplanting, B-10 weeks after transplanting; FM-Soil amendment; CDA- cow-dung ash, RCD-raw cow-dung, NNA-non-nutrient applied, AF-artificial fertilizer, AF+RCD+CDA-artificial fertilizer, raw cow-dung and cow-dung ash are soil amendments types; Std dev- Standard deviation, SE- Standard error of the mean. Std dev=Standard deviation, SE=Standard error of the mean. – Missing data ENG- English giant, HOB- Hobson and RAM-Rampart rape

Table 3. Evaluation of genotypic mean vitamin C (mg/ kg) performance across fertilizer amendments and age of rape

AGE	FM	ENG	HOB	RAM
A	AF	213.47	308.33	196.97
A	AF+RCD+CDA	193.32	191.76	215.06
A	CDA	760.29	392.85	316.37
A	NNA	233.59	-	402.34
A	RCD	671.78	225.18	390.47
A	RCD+CDA	214.13	211.59	438.44
B	AF	246.79	246.49	111.91
B	AF+RCD+CDA	257.69	224.73	165.74
B	CDA	77.42	190.41	280.72
B	NNA	224.26	168.23	307.68
B	RCD	278.17	190.39	256.85
B	RCD+CDA	311.51	201.53	279.69
	mean	306.87	231.95	280.19
	Std dev	200.15	65.19	98.77
	+/-SE	**57.78**	**18.82**	**28.51**

A=6 weeks after transplanting, B=10 weeks after transplanting; FM- Fertilizer amendment: CDA=cow-dung ash, RCD=raw cow-dung, NNA=non-nutrient applied, AF=artificial fertilizer, AF+RCD+CDA=artificial fertilizer and cow-dung ash are soil amendments types; Std dev=Standard deviation, SE=Standard error of the mean. – Missing data ENG- English giant, HOB- Hobson and RAM-Rampart rape

4. DISCUSSION

Rape is an essential source of nutrients and also a key income earner for small scale farmers. Therefore, research which seeks to enhance yield and maintain or promote nutrient content is an important undertaking. In this research, genotypic effects on selected nutritional content were evaluated across fertilizer amendments utilized in Zambia. Evaluation across several fertilizer amendment gives a precise mean nutrient content value to infer from.

The mean fiber content was found to be higher at week 10 than week 6 (Table 2). This could be because at latter stages of growth in rape, the plants tend to reduce in growing vegetatively and put up more lignin in their xylem vessels which increases the fiber content [1]). Fiber makes rape hard to chew, explaining why most consumers found younger rape more palatable than old ones. On the other hand, vitamin C was higher at week 6 across soil amendments and genotypes (P= 0.05) compared to 10 weeks and this may be attributed to the plants utilizing part of the vitamin C in other metabolic processes [7]. Fiber is important in the body to improve digestion and absorption of other nutrients into blood streams by reducing constipation [13]. Lack of fiber nutrient in the diet may lead to constipation, poor blood flow and weak digestive muscles. Thus, where there is need for fiber as a dietary need to alleviate constipation, rape with approximate 10 weeks old can be recommended. Vitamin C plays an important role in improving good skin health and protein metabolism and quick healing of the wound [14]. Vitamin C deficiency can lead to poor skin health and gum breeding. Therefore, in terms of nutrition, young (6 week-old) rape is a better remedy but where higher level of fiber is required, old approximate 10- week rape can be preferred.

This study revealed that genotypic differences did not have any effect on fiber and vitamin C content of rape. This is contrary to previous studies that suggested that genotypic nutrient differences where obtained among genotypes of *brassica species* [15]. The differences may imply that the genetic allele effect responsible for expression of vitamin C, an essential antioxidant molecule and fiber content are similar in all the three genotypes understudy. Inferring that there is a possibility of these genotypes sharing the same ancestry. On the other hand, previous studies have shown that nutrient/ element changes in the growth medium leads to variations in genotypic responses with regards to agronomic parameters [16,17]. Denoting that a similar effect could be true with regards to nutrient quality parameters such as vitamin C and fiber content in rape. Therefore, further research should be undertaken to assess the specific effects of fertilizer amendment on vitamin C and fiber contents.

5. CONCLUSION

Fiber content was higher at 10 weeks than at 6 weeks after transplanting (P< 0.001), while vitamin C was higher at week 6 than week 10 (P= 0.05). Implying that younger leaves are likely to supply a higher content of vitamin C than older ones. The lesser content of fiber at younger stage of rape explains why most consumers found rape more palatable at a younger stage. Further, it was also revealed that the rape genotypes did not influence the evaluated nutrient content (Vitamin C and fiber).

6. RECOMMENDATIONS

There is need to embark on a study to further evaluate the precise effects of fertilizer amendment on vitamin C and fiber contents.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mingochi DS, Luchen SW. Improved vegetable production practices for small holder farmers in Zambia. A reference manual for field extension workers. Small holder irrigation and water use programme Document. No. 1, MAFF, FAO. Field; 2000.
2. Mayuniyuni M, Tembo L. Agronomic yield performance of rape and assessment of discrimination of soil fertilizer amendments on genotypic responses. International Journal of Plant and Soil Science. 2022;34(3):83-91
3. Chipomho J, Tauro T, Linda M, Chipomho C, Mashingaidze B. Influence of organic and inorganic amendments on rape (*Brassica napus L*.) leaf yield and weed dynamics in a highly degraded sandy soil at Marondera, Zimbabwe. A Journal of Applied Science in Southern Africa. 2018;24(1):50-681.
4. Mukonde PM. Performance of rape (*Brassica napus*) grown under organic farming compared to conventional practices. Masters thesis, University of Zambia; 2009.
5. Nyakudya IW, Jimu I, Marashe M, Katsvanga CAT., Comparative growth and yield responses of Rape (*Brassica napus* L.) to different soil fertility management amendments. Electronic Journal of Environmental, Agricultural and Food Chemistry. 2010;9:2007-2014.
6. Lykkesfeldt J, Michels A J, Frei B. Vitamin C. Advanced Nutrition. 2014;5(1):16-18.
7. Fenech M, Amaya I, Valpuesta V, Botella MA. Vitamin C content in fruits: biosynthesis and regulation. Frontier Plant Science. 2019;9:1 -21.

8. Shailja C, Shailendra D, Kamla KS, Placheril JJ, Praveen S. Vitamin C in disease prevention and cure: An overview. Indian J Clin Biochem. 2013;28(4):314–328.
9. Baron JH. Sailors' scurvy before and after James Lind – a reassessment. Nutritional Review. 2009;67:315–332.
10. Xu, S, Hu J, Tan H, Zhang S. Effects of genotype and environment on Vitamin C content and its heterosis in towel gourd fruits. Journal of Science of Food and Agriculture. 2008;88:290- 293.
11. Kalin S, Phares E, Koh W, Skerrett P, Dart H. The nutrition source. Avaialble:https://www.hsph.harvard.edu/nutritionsource/carbohydrates/. Accessed on 18th May 2022.
12. AOAC. Methods of Analysis-Official methods. Association of Official Analytical Chemists, (Vol. II 17th edition) of AOAC International, Washington, DC, USA; 2006.
13. Mackean DG. Biology, second edition. London: UK. John Murray Publishers, Ltd; 1996.
14. Biggs A. Biology. The Dynamics of Life. Westiville: USA. Mcgraw-Hill; 2007.
15. Conversa G, Lazzizera C, Bonasia A, La Rotonda P, Elia A. Nutritional characterization of two rare landraces of turnip (*Brassica rapa*. var. *rapa*) tops and their on-farm conservation in Foggia Province. *Sustainability*. 2020;12(9): 3842.
16. Ndeke V, Tembo L. Investigating the type of gene action conditioning tolerance to aluminum (Al) toxicity in tropical maize. Asian Plant Research Journal. 2019;2(4):1-8.
17. Tembo L. Effect in hydroponics of nitrogen and aluminium toxicity on tropical maize. Asian Research Journal of Agriculture. 2018;9(2):1-7.

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