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Effect of Hybridization on the Nutrient Compositions of Two Cultivars of *Solanum aethiopicum* L. (Solanaceae) Found in Anambra State

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ABSTRACT

Background and Objective: The desire for modification of valuable crop species for human nutritional fulfilment and economic growth is essential. Two cultivars of *Solanum aethiopicum* L. found in Anambra State were hybridized to raise an F_1 that might combine the attributes of the parental lines for enhancement in yield and biochemical contents for health nutritional requirements. **Materials and Methods:** The emasculation method was adopted, using *Solanum aethiopicum* var. "Anara Adazi as the female parent and transference of functional pollen from *Solanum aethiopicum* var. "Anara" to the stigmas of the emasculated plant at the correct time. Nutrient analysis of the fruits of F_1 and the parental plants was carried out using the standard method. Analysis of variance was used for data analysis. **Results:** Results revealed that parental plants and F_1 contained investigated nutrients in varied amounts. Ash content, crude fiber and protein were higher in the fruit of F_1 hybrid (10.90±0.11, 21.50±1.51 and 5.01±0.24), respectively when compared to the fruits of the parental plants. **Conclusion:** Data obtained indicated that when two *Solanum aethiopicum* plants of different but closely related cultivars are crossbred, a new hybrid that possesses enhanced characteristics of the two parent plants is produced. Results of the nutrient analysis demonstrated that hybridization could significantly increase food nutrients in eggplant *(Solanum aethiopicum)*.

KEYWORDS

Hybridization, hybrid, nutrient compositions, *Solanum aethiopicum*, eggplant, cultivars

INTRODUCTION

Solanum aethiopicum is a cultivated eggplant native to Africa[1]. It is one of the dominant vegetables in tropical Africa[2]. The fruit, leaves, shoots and roots of *S. aethiopicum* are used for both food and medicinal purposes and the specific use depends on the geographic area and/or plant type whereas fruits, leaves and roots of bitter cultivars are used as medicine in many African countries to treat ailments ranging from colic and high blood pressure to uterine complaints[3-5].

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Various cultivars of *Solanum aethiopicum* exist due to differences in morphological and biochemical characteristics. Some cultivars are cultivated for their edible fruits and leaves while others are cultivated for their edible fruits only[2].

However, there are two cultivars of *S. aethiopicum* (*Solanum aethiopicum* var. "Anara Adazi" and *Solanum aethiopicum* var. "Anara") commonly grown and found in Anambra State. One is grown and found mainly in Adazi town in Anambra State. It is called "Anara Adazi" in Igbo because they are the major people that produce it in Anambra State and the variety grows and performs well in Adazi town more than in any other place. It is normally grown for its edible fruit. It is about 2 m in height. The stem, branches and leaves are hairy and usually armed with prickles thus not edible. The cultivar is particularly grown for its edible fruit which is sweet and sometimes a little bitter. The fruit shape is like a hen's egg or oval with stripes. It is consumed mostly unripe which is pale green in color[6].

The other cultivar is grown for its edible fruits and leaves. It is cultivated by every farmer in Anambra State unlike "Anara Adazi". It is about 1.5 m in height, thus var. "Anara Adazi" produces more branches and probably more fruits. The stem, branches and leaves are without hair or prickles and thus edible unlike "Anara Adazi". The fruit shape is round with ribs. The fruit size is smaller than that of *S. aethiopicum* 3-6 cm in diameter. The leaves and fruits are relatively bitter and more medicinal hence; old people prefer it to "Anara Adazi". "Anara Adazi" is preferably used for the cola to this cultivar. This cultivar is more resistant to pests than the other cultivar[6].

The desire for modification of valuable crop species for human nutritional fulfilment and economic growth is on the increase and highly essential. Plant breeders manipulate the plant attributes, structure and composition to make them more useful to humans. They replace the unsuitable qualities in crops with suitable ones so that it would result in an increased yield of crops of improved qualities through the process of crossbreeding or hybridization. The objective of this study was to assess the effect of hybridization on nutrient compositions of two cultivars (*S. aethiopicum* var. "Anara Adazi" and *S. aethiopicum* var. "Anara") of *S. aethiopicum* L. found in Anambra State.

MATERIALS AND METHODS

Area of study: The experiment was conducted at the research farm of the Department of Botany, Nnamdi Azikiwe University Awka, Anambra State (6°12'N, 7°04'E) during the 2019 cropping season from March, 2019 to August, 2020 to determine the effect of hybridization on yield and biochemical compositions of two cultivars of *Solanum aethiopicum* L. (Solanaceae) found in Anambra state. Awka is located in the tropical rainforest zone of Nigeria with average temperatures, annual rainfall and relative humidity of 29°C, 2700 mm and 87%, respectively.

Design of the study: The experiment was laid out in a Randomized Complete Block Design replicated three times.

Procurement and identification of plant materials: The two cultivars of S. *aethiopicum* var. "Anara Adazi" and "Anara" were procured between March-April, 2019 from Adazi town in Anambra State. The cultivars were authenticated at the Department of Botany Nnamdi Azikiwe University, Awka.

Testing the pH of the soil sample: Some of the soil samples for the nursery were put in a clean, dry plastic jar. Stones were removed and clumps were crushed for better results. Three representative samples were gathered for proper confirmation of the soil. About ¾ of the jar was filled with sample sand and distilled water was added to cover the soil. The jar was capped and shaken vigorously a few times. The mixture was left to stand for 10 min to dissolve the salts in the soil. The pH tester was calibrated with a

pH 7 and a pH 10 buffer solution. The jar cap was removed and the pH tester was placed into the wet soil slurry. The pH was then measured and recorded.

Seed viability test: After 20 g seeds of each cultivar were obtained, a viability test was carried out on them. This was done by soaking a handful of each cultivar in a beaker containing distilled water for approximately 3 min; the water was then stirred and allowed to settle. The seeds that floated on the surface of the water were discarded, while those that settled to the bottom of the beaker were selected. The seeds that floated on the surface of the soil were discarded while those that sank to the bottom of the beaker were selected.

Land preparation and sowing: The site for raising seedlings was cleared using a matchet and trash was packed off and burned, a nursery bed of 2.4×3.0 and 0.5 m apart was measured using a measuring tape, measuring rope and pegs and prepared to a fine tilt. Farmyard manure at the rate of 30 t/ha was integrated during this exercise. Three seeds per stand were sown at a spacing of 40×60 cm and later thinned to one seedling per stand when they were about 8-10 cm high. Plots were kept weed free throughout the experiment. Hoeing and hand-pulling methods were used.

Flowering started at about three to four weeks after transplanting and it was at this stage that hybridization was carried out. The artificial crossing was adopted because *Solanum aethiopicum* is a self-pollinating crop. This involved the removal of anthers with a pair of forceps from the *S. aethiopicum* var. "Anara Adazi" cultivar thus using it as a female parent before it dehisces and covering it with a sturdy bag (foil) to avoid natural crossing by insects. This was followed by the collection and transference of ripe pollen grains from the *S. aethiopicum* var. "Anara" (male parent) to the stigma of the emasculated plant var. ("Anara Adazi"). Although several crosses were made only a few were successful. This pollination process was followed by fertilization and subsequent production of fruits (the F_1 hybrid). This procedure was as outlined by Ilodibia *et al.*[7]. The mature fruits of both the parental plants and the F_1 hybrid were harvested and dried before being taken for biochemical analysis.

Preparation of samples for proximate analysis: Dried fruits of two cultivars of *S. aethiopicum* and the F_1 hybrid were ground into fine (100-mesh screen) powder with a dry mill and then examined for proximate analysis.

Proximate analysis: Six nutrients were examined. They include ash content, crude protein, crude fat, crude fiber, moisture content and carbohydrate according to the method of Nimenibo and Omotayo[8] and James[9].

Materials and chemicals used: The following materials were used; Desiccator (Narang Medical Limited, United States of America), muffle furnace (Bionics Scientific Technologies (P) Ltd, Delhi India), spectrometer (Analytik Jena Germany), silica dish, kjeldahl flask, funnel, Soxhlet apparatus, Whatman filter paper no. 42 (SIGMA-ALDRICH Laboratories, United States of America), thimble, electric oven (Bionics Scientific Technologies (P) Ltd, Delhi India), grinder, retort stand, test tube and test tube rack, the crucible, weighing balance, petri dish (Bionics Scientific Technologies (P) Ltd, Delhi India).

Chemicals and reagents used for the studies include Tetrahydrosulphate (vi) acid, Boric acid indicator solution, Sodium hydroxide, Hydrochloric acid, Petroleum ether, Potassium hydroxide, Acetone, Phenolphthaline indicator, Ammonia, Dithezone solution, Carbon tetrachloride, Hydroquinoline, Phenonthroline, Vanado Molybidic acid, Selenium oxide (Biological Science Laboratory and Research, Nnamdi Azikiwe University, Awka, Nigeria).

Statistical analysis: Data collected were analyzed using Analysis of Variance (ANOVA) and treatment means were separated using DMRT at a 5% level of probability. Results were presented in Mean±Standard deviation.

RESULTS

Results of the study are presented in Table 1 and Fig. 1-6

Proximate result: Proximate results (Table 1) revealed varying quantities of the six nutrients in the fruits of *S. aethiopicum* cultivars and F_1 hybrid. Ash content, crude fiber and protein were highest in the fruit of the F_1 hybrid. Moisture content, fat content and carbohydrate were highest in the fruit of S. *aethiopicum* var. "Anara" (Table 1).

The plant is in its natural habitat; it is mostly cultivated on a farm as a vegetable (Fig. 1)

Fig. 1: *Solanum aethiopicum* var. "Anara Adazi" plant in its natural habitat

Fig. 2: Twig of *Solanum aethiopicum* var. "Anara Adazi"

Fig. 3: *Solanum aethiopicum* var. "Anara" plant in its natural habitat

Fig. 4: Twig of *Solanum aethiopicum* var. "Anara"

Table 1: Percent proximate content of the fruits of *Solanum aethiopicum* cultivars and F_1 hybrid

Plants	Moisture content (%)	Ash content (%)	Crude fiber (%)	Fat content (%)	Protein (%)	Carbohydrate (%)
Var. "Anara Adazi"	8.45±5.52	10.80±0.05	21.24±1.12	30.15±0.03	4.90±0.08	15.20±0.04
Var."Anara"	8.67±5.60	10.84±0.02	20.09±1.04	30.25±0.03	4.50±0.86	15.35±1.09
	7.22±6.24	10.90±0.11	21.50±1.51	29.19±0.05	5.01±0.24	14.05±1.20

Results were in Mean±Standard deviation

The stem, leaf, fruit and flower morphology of "Anara Adazi" is shown in Fig. 2. The stem, branches and leaves are hairy and usually armed with prickles thus not edible. The cultivar is particularly grown for its edible fruit which is sweet and sometimes a little bitter. The fruit shape is like a hen's egg or oval with stripes. The flower colour is white.

The plant *S. aethiopicum* var. "Anara" plant in its natural habitat is shown in Fig. 3, it is mostly cultivated on a farm as a vegetable.

The stem, leaf and fruit morphology of *S. aethiopicum* var. "Anara" is shown in Fig. 4. The stem, branches and leaves are without hair or prickles and thus edible. The fruit shape is round with ribs.

Fig. 5: F_1 hybrid produce by cross between "Anara Adazi" and "Anara"

Fig. 6: Fruits of parents compared with the fruit of F_1

(P_1) *Solanum aethiopicum* var. "Anara Adazi" (P_2) *Solanum aethiopicum* var. "Anara" (F_1) the hybrid

The progeny of a cross between S. *aethiopicum* var. "Anara Adazi" and *S. aethiopicum* var. "Anara" produce the F_1 hybrid as shown in Fig. 5.

The fruits of parental plants (*S. aethiopicum* var. "Anara Adazi" and *S. aethiopicum* var. "Anara") were compared with the fruits of F_1 (Fig. 6). The F_1 hybrid had more features of S. *aethiopicum* var. "Anara Adazi" than *S. aethiopicum* var. "Anara.

DISCUSSION

Results of the study revealed varying quantities of the six nutrients in the fruits of *S. aethiopicum* cultivars and F_1 hybrid. Ash content, crude fibre and protein were highest in the fruit of F_1 hybrid (10.90±0.11, 21.50±1.51 and 5.01±0.24), respectively. Moisture content, fat content and carbohydrate were highest in the fruit of *S. aethiopicum* var. "Anara" (8.67±5.60, 30.25±0.03 and 15.35±1.09), respectively (Table 1).

Results implied that when two *S. aethiopicum* plants of different but closely related cultivars are crossbred, a new hybrid that possesses enhanced characteristics of the two parent plants is produced. This is an expression of heterosis. Secondly, when two plants with any pair of contrasting characteristics are crossbred, one of the characters would often appear in the hybrid while the other remains hidden.

The results acquiesced with what Ilodibia *et al.*[7] reported that when two crops with a pair of allelic genes are crossbred, one of the allelic genes would often manifest in the hybrid while the other belaved masked. The manifested allele was called the dominant allele while the masked one was called the recessive allele. Hence, Mendelian law of segregation states that the characteristics of a diploid organism are controlled by alleles occurring in pairs, a pair of such alleles, only one can be carried in a single gamete. Correspondingly, the result of the study (Fig. 6) fruits of parents compared with the fruit of F_1 indicated that *S. aethiopicum* var. "Anara Adazi" has a number of dominant characteristics. This was also in line with the view of Ilodibia *et al.*[10] that the result of hybridization is a new hybrid which has the attributes of the two parents, though the attributes shown in the hybrid relate more to one parent than the other. In addition, the F_1 hybrid however manifested an expression of heterosis and possesses fruits that are shorter than that of *S. aethiopicum* var. "Anara Adazi" but larger than that *S. aethiopicum* var "Anara. This was in agreement with the findings of Ilodibia *et al.*[11] in which the cross *between C. annuum* and *C. frutescens* occurred. The results indicated that the F_1 hybrid had the highest quantities of Ash content, crude fibre and protein when compared with the parents. This showed that the hybridization of two cultivars of *S. aethiopicum* could richly improve nutrients in *S. aethiopicum* thus complementing heterosis. This conformed to the findings of Ilodibia *et al.*[12], who reported greater proportions of nutrients in the F_1 hybrid than the parent plants of two Capsicum species crossbred, also, with that of Velu *et al.*[13] that competitively Zn and Fe nutritionally enhanced varieties can be created. The results agreed with the findings of Ilodibia *et al.*[7] that crossbreeding can result in enhancement in genetic variation in the population. The F_1 hybrid is thus a better option for ash content, crude fibre and protein than the parental plants. These nutrients are substances that provide nourishment essential for the maintenance of life and for growth Ilodibia *et al.*[14]. The authors recommend and encourage other researchers to carry out hybridization, especially on important vegetables for nutritional and health satisfaction.

Authors experienced some limitations during the procurement of the right varieties for cultivation and planting because the varieties do not grow and perform well in any place. The implication was that it made the whole work last longer than expected and cost more than planned.

CONCLUSION

It is concluded that when two *Solanum aethiopicum* plants of different but closely related cultivars are crossbred, a new hybrid that possesses enhanced characteristics of the two parent plants is produced. Results of the nutrient analysis demonstrated that hybridization could greatly enhance food nutrients in the *Solanum aethiopicum* plant. This is a powerful expression of hybrid vigour. Secondly, when two crops with a pair of allelic genes are crossbred, one of the allelic genes would often manifest in the hybrid while the other belaved masked and the results revealed that the F_1 hybrid resembled *Solanum aethiopicum* var. "Anara Adazi" more than *Solanum aethiopicum* var. "Anara".

SIGNIFICANCE STATEMENT

The study discovered a new hybrid obtained from the hybridization of two cultivars of *S. aethiopicum* L. found in Anambra State was discovered. The hybrid had in addition to the parent's traits other attributes. The study is beneficial to farmers and consumers. The hybrid though smaller in size than *S. aethiopicum* var. "Anara Adazi" but bigger than *Solanum aethiopicum* var. "Anara". The hybrid had more nutrients than the parental plants and complemented the existing nutrients for human health and nutritional satisfaction. This study will help the researcher to unfold the critical areas of breeding problems in this species that

many researchers were not able to explore. Thus, it intensifies information that could aid other breeding efforts aimed at maximizing the species' potential for use as ornamentals and medicinal plants.

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