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Alternative Use of Black and Navy Beans as Green Shell Beans

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Abstract. **Although there is increasing consumer interest in newer foods such as green seeds, green shell bean production in Virginia is nonexistent. We conducted replicated field studies during 2022–23 to characterize production potential of green shell beans and green seeds from black and navy beans. Average green pod and green seed yields were 10,121 and 5186 kg·ha^{-1}, respectively, whereas average seed number per pod was 3.6. As a group, black beans had a higher shelling percent than navy beans, with an average shelling percent of 54%. Green seeds from black and navy bean contained 26% protein, 82 mg·kg^{-1} Fe, and 38 mg·kg^{-1} Zn in addition to appreciable concentrations of other nutrients. Our results indicated that black and navy beans have potential as alternative crops to supply green seeds.**

Common bean (*Phaseolus vulgaris* L.) is an important economic crop in the United States and globally (Uebersax et al. 2023). Most beans in the genus are commercially classified into three groups (Chaurasia 2020): snap beans, green beans, or string beans. These are consumed as tender, immature pods; shell beans—immature, green seeds removed from the pods for consumption; and dry beans—mature seeds removed from the pod after being dried completely. In this article, we use the term "green shell beans" to include green pods and seeds.

Green seeds are traditionally consumed in several countries in Latin America, the Caribbean, Africa, and Europe, where bean pods are harvested near physiological maturity (Beaver et al. 2020). Consumption of green legume seeds such as edamame [*Glycine max* (L.) Merr.], green peas (*Pisum sativum* L.), and lima bean (*Phaseolus lunatus* L.) in the United States has increased significantly in recent decades with considerable quantities of these legumes being imported (Duncan et al. 2020). However, production of green seeds from common bean are largely unknown in Virginia and elsewhere in the United States.

We are interested in development and establishment of green shell beans as an alternative niche crop. Objectives of the current study were to characterize production and nutritional quality of black and navy green seeds produced in Virginia.

Materials and Methods

The planting and harvesting dates (Randomized Complete Block Design with three replications) were 1 Jul and 15 Sep in 2022 and 15 Jun and 8 Sep in 2023. The plot area received 1.25 L·ha^{-1} of trifluralin (Treflan) herbicide as a preplant incorporated treatment ~1 week before planting. Approximately 100 seeds were planted in each of the four rows of each plot with a research planter at a depth of ~2 to 3 cm. We harvested physiologically mature green beans from 0.6-m row length of two replications each of six black and four navy bean varieties at R6 stage (Table 1). This stage of bean growth corresponds, in general terms, to physiological maturity in soybean (Fehr et al. 1971). Number of pods/ha, pod yield kg·ha^{-1}, and seed weight kg·ha^{-1} were calculated. We used 25 pods from each plot to record number of seeds, fresh weights of seeds, and fresh weights of shells. Dried green seeds were analyzed by Waypoint Laboratory, Richmond, Virginia, USA for N, P, K, Mg, Ca, S, Fe, Mn, Cu, Zn, and B. Protein concentrations were determined as N*6.25.

All data were analyzed using SAS (2016). We used analysis of variance to obtain mean squares for years, varieties, year × variety interaction, and replications. Significance of mean squares was tested on probability of significant *F* values using 5% as level of significance.

Results and Discussion

Results from studies conducted during 2022 and 2023 indicated that both black and navy beans have potential as green shell beans. We used black and navy bean varieties (Table 1) for these studies because these varieties were part of a larger study where effects of planting dates and row spacings on dry seed yields and related traits were being studied. Average values for pod (ha^{-1}), pod yield (ha^{-1}), green seed yield (ha^{-1}), seed number (pod^{-1}), and shelling percent were 2,912,548, 10,121, 5186, 3.6, and 54, respectively. In general, there was lack of significant differences between black and navy beans, and among six black bean and among four navy bean varieties. There were significant differences between 2 years of production for all traits except for pod yield and seed yield. As a group, black beans had a higher shelling than navy beans. Green seeds from black and navy bean had similar protein concentrations, ~26%.

We compared seed composition of green seeds produced in our studies to that of cowpea (*Vigna unguiculata* L. Walp.). Cowpea is a crop similar to black and navy beans in many respects, including production and use as green shell beans (Carvalho et al. 2022; Gerrano et al. 2017). The nutritional quality of green seeds from black and navy beans in our studies compared well with literature values for cowpea and edamame (Table 2). Protein concentration in black and navy bean green seeds (~26%) was lower than that in cowpea (~29%) and edamame (~40%).

We are encouraged by these results, while being aware that they are from a limited study. However, the results provide evidence that use of black and navy beans as shell beans in Virginia, USA, has positive potential. Our results are also supported by extensive research conducted in Washington State, USA (Miles

Table 1. Green shell bean data from black and navy beans grown in Virginia during 2022–23.

Bean type	Variety name	Pod no. (ha^{-1})	Pod yield (kg·ha^{-1})	Seeds (pod^{-1})	Seed wt (kg·ha^{-1})	Shelling %	Protein %
Black	Eclipse	2754386 a	6458 a	3.33 a	4017 a	64.66 a	26.47 a
	Condor	3351528 a	8911 a	3.34 a	5332 a	62.12 a	25.47 a
	Jet Black	2388569 a	10333 a	3.61 a	5237 a	51.59 a	26.03 a
	Midnight Black	2313254 a	9764 a	3.88 a	5036 a	52.98 a	27.39 a
	Zenith	3007230 a	11684 a	3.90 a	5593 a	51.71 a	25.91 a
	Zorro	2926535 a	9136 a	4.17 a	5664 a	64.32 a	25.56 a
Navy	Alpena	3028749 a	11399 a	3.95 a	5937 a	54.61 a	24.17 a
	Cascade	2867359 a	8295 a	3.43 a	4088 a	53.04 a	25.92 a
	Portage	3265454 a	12904 a	3.16 a	5960 a	43.19 a	26.28 a
	Teton	3222416 a	12335 a	3.05 a	5000 a	44.55 a	27.97 a
Avg of black bean varieties		2790250 a	9381 a	3.71 a	5146 a	58.06 a	26.14 a
Avg of navy bean varieties		3095994 a	11233 a	3.40 a	5246 a	48.85 b	26.09 a
Avg for 2022		3662473 a	13307 a	3.75 a	6972 a	54.78 a	27.08 a
Avg for 2023		2162623 b	6937 b	3.42 a	3401 b	53.98 a	25.16 b

Means followed by similar letters were not statistically different at 5% level of significance.

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Table 2. Composition of green seeds of black and navy bean grown in 2022 and 2023 at Petersburg, VA, USA and literature values of cowpea and edamame (vegetable soybean).

Trait	Black beans[i]	Navy beans[i]	Cowpea[ii]	Edamame[iii]
Protein[iv]	26.14 a	26.09 a	29.43	40.28
P[iv]	0.52 a	0.54 a	4.77	—
K[iv]	1.76 a	1.79 a	1.09	1.889
S[iv]	0.24 a	0.24 a	0.07	—
Ca[iv]	0.20 b	0.26 a	0.07	0.262
Mg[iv]	0.24 a	0.25 a	0.18	0.234
Fe[v]	81.3 a	83.1 a	58.44	73.8
Mn[v]	19.91 a	20.61 a	17.31	31.9
Cu[v]	9.34 a	9.68 a	6.75	—
Zn[v]	37.36 a	38.32 a	46.12	27.8
B[v]	9.09 a	9.35 a	11.08	—

[i] Values are from current study.
[ii] Carvalho et al. (2022).
[iii] Agyenim-Boateng et al. (2023).
[iv] g/100 g, dry weight basis.
[v] $mg \cdot kg^{-1}$, dry weight basis.
Means followed by similar letters were not statistically different at 5% level of significance.

et al. 2006) and Puerto Rico (Beaver at al. 2020), indicating great potential of shell beans as niche crops. We suggest that further research be conducted to characterize consumer acceptability and economic value of green shell beans from black and navy beans. This information is currently unavailable from Virginia.

Conclusions

Our results demonstrate that black and navy beans are potential alternative crops for Virginia farmers to provide green seeds for human consumption. On the basis of our results, both black and navy beans are suitable for production of green shell beans in Virginia. However, these results need verification based on trials involving a larger number of black and navy bean varieties conducted over different locations.

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