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(RESEARCH ARTICLE)



Phenotypic variability studies in selected accessions of Nigerian wild cowpea (*Vigna unguiculata* L. Walp)

Usman Benjamin, Falusi Olamide, Daudu Oladipupo Abdulazeez Yusuf, Abubakar Abdulhakeem, Nwosu Dickson Junior, Titus Segun David * and Muhammad Liman Muhammad.

Department of Plant Biology, Federal University of Technology Minna, Niger State, Nigeria

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Abstract

This study was carried out to evaluate the genetic variability among twenty (20) wild cowpea (*Vigna unguiculata*) accessions collected from National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Nigeria. The seeds of wild cowpeas were planted in the Experimental Garden of Plant Biology, Federal University of Technology Minna and nurtured to maturity. The experiment was laid in a Randomized Complete Block Design (RCBD) with five replicates each and assessed for agro-morphological and yield parameters. The results showed significant deference ($p \leq 0.05$) in most of all the morphological parameters studied. NGB-001145 showed the highest plant height at maturity (26.10 cm), while NGB-001158 had the least plant height at maturity (14.90 cm). NGB-001033 had some superior qualities with earliest mean days (44.40) to flowering, highest number of branches at maturity (7.20) and highest number of pod per plant with the mean of 104.00 pods. The least number of branches a maturity (4.00) and number of pod per plant (22.80) were obtained from accessions NGB-001128 and NGB-001034 respectively. NGB-001145 showed the highest number of seeds per pod (13.40), while NGB-00994 recorded the least number of seeds per pod with the mean value of 5.40. NGB-001166 had the highest seed weight (4.68 g) and NGB-001934 had the least seed weight (2.08 g). The high morphological variability observed among the wild cowpea in this study indicated the presence of good and useful traits in the crop which could be explored for its improvement.

Keywords: Accession; Cowpea; Variability; *Vigna unguiculata*

1. Introduction

Cowpea (*Vigna unguiculata* L. Walp) is a legume belonging to the family Fabaceae. It is a warm weather annual crop that is well adapted to drier regions of the tropics where other food legumes do not thrive well. Cowpea is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world [1]. The major cowpea producing states in Nigeria include: Kaduna, Katsina, Zamfara, Bauchi, Sokoto, Kebbi, Plateau, Adamawa, Taraba, Gombe, Borno, Yobe, Jigawa, Niger, Benue, Nasarawa and Kano where it is grown traditionally and intercropped with cereals such as maize and sorghum [2].

*Corresponding author

E-mail address: titusdavids@yahoo.com

Cowpea provides food for several millions of people in developing countries, in fact it's sometimes being referred to as "poor man's meat" [3]. The crop has the largest usable protein content of all cultivated legumes and considered as one of the most important plant protein source which is valuable and dependable commodity crop for farmer and grain traders [4]. Cowpea forms excellent forage and it gives a heavy vegetative growth and covers the ground so well that it checks the soil erosion. As a leguminous crop, it fixes about 70 – 240 kg per ha of nitrogen per year. The crop is well known for its nutritional benefits as the grain is rich in protein while fresh pods and vegetative parts are rich in minerals and vitamins. In addition to the culinary benefits, cowpea improves soil fertility through nitrogen fixation. It is also a potential source of income through sales [2, 3]. The crop is adapted to drought prone areas in comparison with other grain legumes [6, 7].

Despite all the aforementioned advantages, the major drawback of cowpea is its low yield, mainly due to lack of improved varieties, poor soil fertility and abiotic constraint that reduced the growth and yield of cowpea [8]. As for biotic stresses, insects cause the most severe damage and this may reach 100% yield loss, if not well handled [9, 10].

In most West African countries, development and release of improved varieties of cowpeas that adapts well and yield better have been slow in getting to the farmers [11]. The wild species of *Vigna* have been reported to be important reservoirs of many useful genes, especially genes for tolerance to major biotic and abiotic stresses, and can be used to improve the cultivated species for breeding programs [12].

Due to the great prospects of wild species as potential source of valuable traits, morphological evaluation of wild cowpea will provide substantial information on the improvement of its production. The identification and differentiation of the relatedness of wild cowpea germplasm will be useful for breeding programs in Nigeria, this will contribute to efforts meant to maximizing the selection of diverse parent genotypes and to broaden the germplasm for future cowpea breeding programs in developing improved cultivars. Keeping this fact in mind, the present research was designed to evaluate the phenotypic variability in selected Nigerian wild cowpea (*Vigna unguiculata* L.) accessions.

2. Material and Methods

2.1. Seed Collection

Seeds of twenty (20) accessions of wild cowpea were collected from the Gene Bank of National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Nigeria. The twenty accessions collected were; NGB-00994, NGB-001128, NGB-001158, NGB-001034, NGB-001095, NGB-00106, NGB-001156, NGB-00117, NGB-001141, NGB-001131, NGB-001033(11), NGB-001152, NGB-001130, NGB-00169, NGB-001006, NGB-001027, NGB-001162, NGB-001166, NGB-001146 and NGB-001145.

2.2. Experimental Design

The experiment was conducted at the Experimental Garden of the Department of Plant Biology, Federal University of Technology, Minna, Nigeria in a Randomized Complete Block Design (RCBD) with five replicates each. A total of three viable seeds of each accession were planted in 7 liters experimental pots, filled to 5 liters mark with sandy-loamy soil. All agronomic practices were carried out when necessary and the plants were monitored for morphological parameters viz; germination percentage, plant height at maturity (cm), number of branches at maturity, length of pod (cm), number of pod per plant, number of seeds per plant, 100 seed weight (g), days to first flowering and days to harvest.

2.3. Data Analysis

Agro-morphological parameters were collected according to standard procedures of [13] and [14] with minor modification. The data generated were subjected to statistical analysis using Analysis of variance (ANOVA) to test for significant differences and Duncan's Multiple Range Test (DMRT) was used to separate the means where there were differences. All data analysis was carried out using the Statistical Package for Social Science version 20 at 5% level of significance.

3. Results and discussion

3.1. Morphological Parameters of the 20 wild cowpeas evaluated

The results of the morphological parameters of the twenty (20) wild cowpeas accession are presented in Table 1. The result revealed that the accessions NGB-00994, NGB-00106, NGB-001141, NGB-001130, NGB-001027 and NGB-001166 showed a significant ($P \leq 0.05$) highest germination percentage of 100%. Distinct variation in plant height was observed among the twenty accessions at maturity with accessions NGB-001145 having significant ($P \leq 0.05$) highest plant height of 26.10 cm at maturity, while accessions NGB-001158 had the shortest height of 14.20 cm.

The numbers of branches per plant at maturity ranged from 4 to 7 in each accession. Accession NGB-001033 had a significant ($P \leq 0.05$) highest number of branches at maturity with the mean value of 7.20, while accession NGB-001128 had a significant ($P \leq 0.05$) least number of branches at maturity with the mean value of 4.00.

Table 1 Mean value of morphological parameters of 20 accessions of wild Cowpea evaluated

S/N	ACC. NO.	Germination%	PLH@M(cm)	NOB@M
1	NGB – 00994	100.00±0.00 ^c	17.70±0.82 ^{abc}	4.40±0.40 ^{abc}
2	NGB – 001128	60.00±0.37 ^{ab}	15.90±0.80 ^{ab}	4.00±0.55 ^a
3	NGB – 001158	93.33±0.20 ^c	14.20±0.85 ^a	4.40±0.24 ^{abc}
4	NGB – 001034	60.00±0.37 ^{ab}	14.90±1.27 ^a	5.20±0.37 ^{abcde}
5	NGB – 001094	93.33±0.20 ^c	16.90±0.75 ^{ab}	5.40±0.24 ^{abcde}
6	NGB – 00106	100.00 ±0.00 ^c	19.80±3.03 ^{bcd}	5.40±0.40 ^{abcde}
7	NGB – 001156	73.33 ±0.20 ^{abc}	24.40±3.11 ^{de}	4.20±1.07 ^{ab}
8	NGB – 001177	86.67 ±0.40 ^{bc}	25.40±0.87 ^e	5.40±0.24 ^{abcde}
9	NGB – 001141	100.00 ±0.00 ^c	23.00±1.44 ^{de}	5.40±0.24 ^{abcde}
10	NGB – 001131	93.33 ±0.20 ^c	25.10±0.81 ^e	4.80±0.37 ^{abcd}
11	NGB – 001033	93.33 ±0.20 ^c	25.00±1.14 ^{de}	7.20±0.86 ^f
12	NGB – 001152	46.67 ±0.51 ^a	22.00±1.77 ^{cde}	5.80±0.37 ^{cdef}
13	NGB – 001130	100.00 ±0.00 ^c	22.90±1.61 ^{de}	5.40±0.24 ^{abcdf}
14	NGB – 00169	73.33 ±0.37 ^{abc}	22.10±1.80 ^{cde}	5.80±0.37 ^{cdef}
15	NGB – 001006	80.00 ±0.24 ^{bc}	22.60±1.88 ^{cde}	6.00±0.00 ^{def}
16	NGB – 001027	100.00 ±0.00 ^c	22.90±2.03 ^{de}	6.60±0.51 ^{ef}
17	NGB – 001162	60.00 ±0.37 ^{ab}	21.70±1.30 ^{cde}	5.60±0.68 ^{bcde}
18	NGB – 001166	100.00 ±0.00 ^c	22.30±1.32 ^{cde}	6.60±0.40 ^{ef}
19	NGB – 001146	80.00 ±0.25 ^{bc}	25.40±0.80 ^e	5.80±0.37 ^{cdef}
20	NGB – 001145	93.33 ±0.20 ^c	26.10±0.33 ^e	6.00±0.00 ^{def}

Values are means of five replicates ± standard error. Means followed by the same superscript down the column are not significantly different ($P > 0.5$). GERM- germination, PLH@M- plant height at maturity (cm), NOB@M- number of branches at maturity.

This result showed that great genetic variability exists in agro-morphological traits among the accessions of cowpea evaluated which could be explored for the crop improvement. These traits have been reported to be of great importance in classification of cowpea genotypes [15-18]. The result of [19] also showed that most of the agro-morphological characters evaluated were significantly different from each other.

3.2. Yield and yield components of 20 accessions of wild Cowpea evaluated

The results of the yield and yield components of twenty (20) accessions of wild cowpea evaluated are showed in table 2. The results showed that the mean values for days to first flowering tremendously varied among the 20 accessions studied. These values ranged from 45 to 81 days with accession NGB-001027 having the highest with the mean days of 81.00 days. The accession NGB-001033 on the other hand had the lowest mean days of 45.00. A significant variation ($P \leq 0.05$) in the number of pods per plant was also observed among all the accessions evaluated with accession NGB-001033 having the highest number of pods per plant (104.00) and accession NGB-001034 having the lowest number of pods (22.80) per plant. This is in agreement with the work of [15] who observed significant variations in the number of pods per plant of some African cowpea genotypes.

The accessions NGB-001097 had significant longest pod lengths (9.03 cm). The mean values for days to harvest significantly ($P \leq 0.05$) differed among the accessions evaluated with the values ranging from 63.60 to 115 days. Accession NGB-001027 had the highest mean value of 115.00 days to harvest and NGB-001033 had 63.60 days, indicating early genotypes. Similarly, a significant ($P \leq 0.05$) variation in number of seeds per pod was observed among the accessions studied with accession NGB-001145 having the highest number of seeds per pod (13.40). There was significant variation ($P \leq 0.05$) in the weight of 100 seeds among the 20 accessions evaluated. The weight ranged from 2.00 to 4.69 grams with accession NGB-001169 having the highest gram with the mean value of 4.69 g.

The variation observed among the accessions in this study indicates the existence of a high genetic base that can be used for varietal improvement. It had earlier been reported by various authors [20, 21] that genetic diversity is the key to the success of a plant breeding program. The differences in the agro-morphological parameters among the accessions could be related to both geographic distance (i.e., environmental variation) and likely to differences in end use. This also indicates that they may likely be of different origin.

Table 2 Yield parameters of 20 accessions of wild Cowpea evaluated

S/N	ACC. NO.	LOP(cm)	NOPP	NOSPP	100 SW (g)	DTFF	DTH
1	NGB – 00994	4.8±0.00 ^{ab}	46.20±11.34 ^{abcd}	5.40±0.24 ^a	2.96±0.03 ^c	71.40±0.40 ^g	88.60±0.24 ⁱ
2	NGB – 001128	6.42±0.41 ^{cd}	31.00±12.24 ^{ab}	6.40±0.24 ^{ab}	2.70±0.08 ^b	74.60±0.24 ^h	91.40±0.40 ^k
3	NGB – 001158	6.87±0.64 ^{de}	66.40±7.01 ^{de}	7.00±0.45 ^{ab}	3.35±0.07 ^{gh}	76.40±0.40 ⁱ	98.60±0.24 ^m
4	NGB – 001034	6.63±0.69 ^{cd}	22.80±3.31 ^a	6.60±0.40 ^{ab}	2.08±0.05 ^a	71.80±0.73 ^g	90.60±0.40 ^k
5	NGB – 001096	9.03±0.22 ^f	37.40±8.00 ^{ab}	12.00±0.32 ^{ef}	3.28±0.01 ^{fgh}	50.60±0.40 ^b	68.40±0.40 ^b
6	NGB – 00106	6.36±0.29 ^{cd}	30.60±9.88 ^{ab}	6.40±0.24 ^{ab}	3.28±0.02 ^{fgh}	66.60±0.87 ^{ef}	84.40±0.40 ⁱ
7	NGB – 001156	6.00±0.17 ^{bcd}	45.80±11.55 ^{abcd}	6.40±0.24 ^{ab}	3.04±0.03 ^{cde}	74.00±1.55 ^h	93.40±0.40 ^l
8	NGB – 001177	8.23±0.73 ^f	66.80±7.06 ^{de}	10.00±1.64 ^{cd}	3.44±0.02 ^h	67.40±0.40 ^f	84.60±0.40 ⁱ
9	NGB – 001141	8.90±0.07 ^f	66.60±7.05 ^{de}	12.20±0.20 ^{ef}	4.08±0.05 ⁱ	60.80±0.20 ^d	75.00±0.32 ^c
10	NGB – 001131	8.66±0.26 ^f	49.00±9.72 ^{abcd}	12.60±0.51 ^{ef}	2.99±0.05 ^{cd}	49.20±0.49 ^b	75.40±0.40 ^{cd}
11	NGB – 001033	8.71±0.13 ^f	104.00±8.14 ^f	12.60±0.51 ^{ef}	3.85±0.02 ⁱ	44.40±0.40 ^a	63.60±0.40 ^a
12	NGB – 001152	7.82±0.61 ^{df}	48.60±8.52 ^{abcd}	9.40±1.21 ^c	3.79±0.00 ⁱ	73.00±0.63 ^{gh}	91.40±0.40 ^k
13	NGB – 001130	8.13±0.39 ^f	85.40±10.26 ^{ef}	12.00±0.55 ^{ef}	3.44±0.07 ^h	60.80±0.49 ^d	77.00±0.32 ^e
14	NGB – 00169	6.05±0.41 ^{bcd}	66.40±6.67 ^{de}	7.40±0.24 ^b	4.69±0.13 ^k	65.40±0.40 ^e	80.60±0.40 ^g
15	NGB – 001006	6.46±0.64 ^{cd}	37.80±4.42 ^{abc}	6.00±0.32 ^{ab}	3.16±0.02 ^{def}	77.40±0.40 ⁱ	100.60±0.40 ⁿ
16	NGB – 001027	5.56±0.04 ^{abc}	30.60±3.36 ^{ab}	6.80±0.20 ^{ab}	3.08±0.05 ^{cde}	80.20±0.58 ^j	114.80±0.49 ^o
17	NGB – 001162	5.50±0.00 ^{abc}	34.20±3.25 ^{ab}	7.20±0.20 ^{ab}	2.68±0.08 ^b	67.00±0.32 ^{ef}	84.00±0.32 ⁱ
18	NGB – 001166	8.87±0.88 ^f	58.60±5.99 ^{cd}	11.40±0.51 ^{de}	4.68±0.13 ^k	53.00±0.63 ^c	76.40±0.40 ^{de}
19	NGB – 001146	4.42±0.08 ^a	32.00±3.62 ^{ab}	6.00±0.00 ^{ab}	3.20±0.00 ^{efg}	66.60±0.24 ^{ef}	82.60±0.40 ^h
20	NGB – 001145	8.49±.33 ^f	53.00±3.32 ^{bcd}	13.40±0.51 ^f	2.73±0.02 ^b	61.40±0.87 ^d	78.40±0.40 ^f
15	NGB – 001006	6.46±0.64 ^{cd}	37.80±4.42 ^{abc}	6.00±0.32 ^{ab}	3.16±0.02 ^{def}	77.40±0.40 ⁱ	100.60±0.40 ⁿ
16	NGB – 001027	5.56±0.04 ^{abc}	30.60±3.36 ^{ab}	6.80±0.20 ^{ab}	3.08±0.05 ^{cde}	80.20±0.58 ^j	114.80±0.49 ^o
17	NGB – 001162	5.50±0.00 ^{abc}	34.20±3.25 ^{ab}	7.20±0.20 ^{ab}	2.68±0.08 ^b	67.00±0.32 ^{ef}	84.00±0.32 ⁱ
18	NGB – 001166	8.87±0.88 ^f	58.60±5.99 ^{cd}	11.40±0.51 ^{de}	4.68±0.13 ^k	53.00±0.63 ^c	76.40±0.40 ^{de}
19	NGB – 001146	4.42±0.08 ^a	32.00±3.62 ^{ab}	6.00±0.00 ^{ab}	3.20±0.00 ^{efg}	66.60±0.24 ^{ef}	82.60±0.40 ^h
20	NGB – 001145	8.49±.33 ^f	53.00±3.32 ^{bcd}	13.40±0.51 ^f	2.73±0.02 ^b	61.40±0.87 ^d	78.40±0.40 ^f

Values are means of five replicate ± standard error. Means followed by the same superscript down the column are not significantly different (P>0.5). LOP- length of pod (cm), NOPP- number of pod per plant, NOSPP- number of seeds per plant, 100 SW- 100 seed weight (g), DTFF- days to first flowering, DTH- Days to harvest

Despite the great genetic variability among accessions observed from this study, there were close relationships among some of the accessions evaluated, presumably because they have been collected from similar locations with similar climate, soil type and exchange of seed between farmers of closed regions. According to Badiane et al. [22], the traditional agricultural practice of cowpea cultivation which consist of the cultivation of the seeds obtained from the same field in subsequent generations without the importation of foreign seeds, probably contributes to genetic uniqueness by strengthening specific local adaptations.

3.3. Qualitative traits of the twenty wild cowpea accessions evaluated

The leaf surfaces of all the wild cowpea accessions evaluated were all smooth, except for the accessions NGB-001097, NGB-001177, NGB-001131, NGB-001033 and NGB-001152 that were having rough surfaces. It was observed that all the wild cowpea accessions studied were having smooth stems, except for the accessions NGB-001097, NGB-001131, NGB-001033, NGB-001130, NGB-001166 and NGB-001145 that had rough surfaces. The stems of the wild cowpea studied varied in colour. Accessions NGB-00994, NGB-001128, NGB-001130, NGB-00169, NGB-001166 and NGB-001145 were completely green without any coloured spot, while all other accessions had a purple colour spots.

There was great diversity in the seed properties of the accessions. The seed colour varies from black, light green to brown. The seeds eye colour of the accessions studied were white except for accessions NGB-001097 and NGB-00106 that were cream white.

It was observed that all the accessions of wild cowpea evaluated produced purple flower colours except for accessions NGB-001130 and NGB-00169 that produced white flower colour and accession NGB-001141 produced pale blue flower colour. Accessions NGB-001097, NGB-001131, NGB-001027, NGB-001166, NGB-001146 and NGB-001145 had black spots on the surfaces of the seeds. Also, accession NGB-001006 had a dirty pink colour on its surface and every other accession had no spot on their surfaces.

The accessions studied also varied in seed shape. The accessions NGB-00994, NGB-001158, NGB-001034, NGB-001177, NGB-001131, NGB-001033, NGB-001146 and NGB-001145 were rounded in shape, while all other accessions were ovoid in shape. The growth habit of the accession varied with accessions NGB-001079, NGB-001131, NGB-001033 and NGB-001152 being erect and accessions NGB-00994, NGB-001034, NGB-001141 and 001162 were climbers. Accessions NGB-001128, NGB-001158, NGB-00169, NGB-001006 and NGB-001166 were semi-erect and all other accessions had trailing type of growth habit. All the accessions of the wild cowpea had straight pod forms except for the accessions NGB-00994, NGB-001177, NGB-001131 and NGB-001033 that had a little curved pod forms (Table 3).

The variation in seed colour, size leaf colour, flower colour observed among all the accessions in this study is in agreement with the work of Gbaguidi *et al.* [23], who worked on 96 varieties of cowpea collected from 53 villages in Benin Nigeria. They reported that there were great variations among the varieties evaluated. This work however, disagrees with the work of Ibrahim [18], who studied 94 accessions of cowpea, 47 accessions from Ghana and 47 accessions from Mali, and discovered that there was relatively low level of genetic diversity of characters between and within the germplasm.

Table 3 Phenotypic Characteristics (qualitative) of 20 wild cowpea accessions

ACC. NO.	Leaf appearance	Stem appearance	Stem colour	Seed colour	Seed size	Seed eye colour	Flower colour	particular features	Seed form	Growth habit	Pod form
NGB – 00994	Smooth	Smooth	Green	Black	Small	White	Purple	-	Rounded	Climbing	Little curved
NGB – 001128	Smooth	Smooth	Green	Brown	Average	White	Purple	-	Little lengthened	Semi-erect	Straight
NGB – 001158	Smooth	Smooth	purple spot	Brown	Small	White	Purple	-	Rounded	Semi-erect	Straight
NGB – 001034	Smooth	Smooth	purple spot	Brown	Average	White	Purple	-	Rounded	Climbing	Straight
NGB – 001096	Rough	Rough	purple spot	Brown	Small	Dirty white	Purple	Black spot	Little lengthened	Erect	Straight
NGB – 00106	Smooth	Smooth	purple spot	Brown	Average	White	Purple	-	Little lengthened	Trailing	Straight
NGB – 001156	Smooth	Smooth	purple spot	Brown	Small	White	Purple	-	Little lengthened	Trailing	Straight
NGB – 001177	Rough	Smooth	purple spot	Brown	Small	White	Purple	-	Rounded	Trailing	Little curved
NGB – 001141	Smooth	Smooth	purple spot	Brown	Average	White	Blue	-	Little lengthened	Climbing	Straight
NGB – 001131	Rough	Rough	purple spot	Brown	Average	White	Purple	Black spot	Rounded	Erect	Little curved
NGB – 001033	Rough	Rough	purple spot	Light green	Small	White	Purple	-	Rounded	Erect	Little curved
NGB – 001152	Rough	Smooth	purple spot	Brown	Small	White	Purple	-	Little lengthened	Erect	Straight
NGB – 001130	Smooth	Rough	Green	Light green	Small	White	White	-	Little lengthened	Trailing	Straight
NGB – 00169	Smooth	Smooth	Green	Brown	White	White	White	Little lengthened	Semi-erect	Semi-erect	Straight
NGB – 001006	Smooth	Smooth	purple spot	Brown	Small	White	Purple	Dirty pink	Little lengthened	Semi-erect	Straight
NGB – 001027	Smooth	Smooth	purple spot	Brown	Average	White	Purple	Black spot	Little lengthened	Trailing	Straight
NGB – 001162	Smooth	Smooth	purple spot	Brown	Average	White	Purple	-	Little lengthened	Climbing	Straight
NGB – 001166	Smooth	Rough	Green	Brown	Average	White	Purple	Black spot	Little lengthened	Semi-erect	Straight
NGB – 001146	Smooth	Smooth	purple spot	Brown	Average	White	Purple	Black spot	Rounded	Trailing	Straight
NGB – 001145	Smooth	Rough	Green	Brown	Small	White	Purple	Black spot	Rounded	Trailing	Straight

4. Conclusion

An overall relatively high level of variability was observed among the accessions for most of the morphological traits (qualitative and quantitative). This great genetic diversity existing among Nigerian wild cowpea could be explored for the improvement of the existing cultivated varieties.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors of this article declared that there is no conflict of interest.

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