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Characterization of medicinal *Senna* genetic resources

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Abstract

At 50% maturity, regenerating *Senna* species were characterized for morphological traits, seed reproduction, and evaluated for regeneration. Quality plants regenerated from all accessions produced 1018 to more than 21,215 total seeds. Principal component analysis revealed which traits contributed the greatest to variability among coffee senna accessions. *Senna* species have potential to produce pharmaceutical products and can be grown as medicinal plants. The flavonoids quercetin and kaempferol found in *Senna* species have been clinically shown to have anti-pancreatic cancer properties.

Keywords: genetic resources; pharmaceuticals; phytochemicals; principal component analysis; *Senna*

Introduction

Senna species are members of the family *Fabaceae* found worldwide (NPGS, 2008). The most important species is tinnevelly senna (*Senna alexandrina* Mill.) currently used in various laxatives. Little is known about the agronomic characteristics of *Senna* species because they have primarily been considered as weeds. Several phytochemicals exist in *Senna* with potential to be used as human medicines. The flavonol quercetin found in coffee senna roots (ILDIS, 1994) has been clinically proven to play a role for the prevention of pancreatic cancer in humans, who smoke (Nothlings *et al.*, 2007). The flavonoid, kaempferol found in *Senna alata* (L.) Roxb. leaves has successfully shown to contain an anti-pancreatic cancer property as well (Nothlings *et al.*, 2007). The terpenoid, betulinic acid found in *Senna obtusifolia* roots has been used to develop an anti-HIV drug currently undergoing clinical trials (Qian *et al.*, 2007). Interestingly, the drug bevirimat contains betulinic acid and has been clinically shown to be antiretroviral for use in HIV therapy regimens (Martin *et al.*, 2007; Smith *et al.*, 2007). *S. alata* has recently been shown to strongly inhibit acne inducing bacteria (Chomnawang *et al.*, 2005). Only sennosides are extracted exclusively from *S. alexandrina* (previousely known as *Senna angustifolia*). Coffee senna is well known for its medicinal properties; however, additional *Senna* species contain useful secondary metabolites for potential use as pharmaceuticals to treat various ailments in humans. However, most of these species at present are not commercial sources of the phytochemicals that they possess due to low concentrations. It is therefore important to identify and develop genotypes having significantly higher concentrations of the relevant phytochemical to become an economically viable source.

The objective of this study was to characterize variability among regenerated medicinal *Senna* species for some important agronomic traits.

Experimental

Coffee senna, *S. alata* (L.) Roxb., *S. alexandrina* Mill., *Senna angulata* (Vogel) [H.S. Irwin and Barneby], *Senna corymbosa* (Lam.) [H.S. Irwin and Barneby], *Senna covesii* (A. Gray) [H.S. Irwin and Barneby] and *Senna uniflora* (Mill.) [H.S. Irwin and Barneby] were regenerated at the USDA, ARS, Plant Genetic Resources Conservation Unit.

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Seedlings of 25–50 from each *Senna* accession were transplanted in field plots. Data recorded were based on a rating of 1–9 for branching and foliage, where 1 = 91–100%; 2 = 81–90%; 3 = 71–80%; 4 = 61–70%; 5 = 51–60%; 6 = 41–50%; 7 = 31–40%; 8 = 21–30%; 9 = 1–20% of the plants are producing branches and foliage. Plant height and width (cm) were recorded at 50% flowering. A similar protocol for plant maturity within each plot was used where 1 = 120–180 d; 5 = 210 d; and 9 = 240 d after greenhouse planting until 50% or more of the plants per plot produced mature seeds. Mature seeds were harvested from each *Senna* accession 2–8 months after transplanting in field plots. A principal component analysis was used to characterize variability among coffee senna accessions regenerated in one environment for morphological and reproductive components.

Discussion

Most of the coffee senna accessions produced branching and foliage indices averaging 5 and 1, respectively (Table 1). Plant height and width ranged from 80 to 180 cm and 40 to 200 cm, respectively, among accessions. Three accessions reached 50% maturity in 4–6 months after planting. However, most reached 50% maturity after 7 months of planting. Variable seed numbers and 100 seed weights were observed among coffee senna accessions. Seed numbers ranged from 1750 to 21,215 with 100 seed weights per accession ranging from 1.40 to 1.92 g for both years.

The first five principal components for coffee senna had eigenvalues > 0.69, and together they explained 93% of the total variation for this group of phenotypic and reproductive traits. The first principal component had an eigenvalue of 2.5926, explaining 37% of the entire variation. Plant height and width contributed greatly to variation for this principal component, with eigenvectors equal to 0.52. The second principal component's eigenvalue was 1.4603 and it explained 21% of the total variation. Maturity, 100 seed weight and branching contributed greatly to variation for this principal component, with eigenvectors above 0.46. The third principal component's value was 0.9282 and it explained 13% of the total variation. Branching and foliage eigenvectors equal to and above 0.55 contributed greatly to its variation. The fourth principal component had 0.8694 as its eigenvalue and it explained 12% of the total variation. One hundred seed weight contributed the greatest amount to its variation. The fifth principal component had an eigenvalue of 0.6904 explaining 10% of the total variation. Branching, foliage and seed number contributed greatly to its variation with eigenvectors equal to or above 0.49.

Accessions of six wild *Senna* allies were successfully regenerated also (Table 2). Interestingly, the US-originating accession PI 279709 (*S. corymbosa*) produced the smallest plants, highest seed number (12,283), but matured late, while the Indian accession PI 214042 produced larger plants and 11,276 seeds. The majority

Table 1. Morphological and reproductive traits of *Senna occidentalis* evaluated from 2004 to 2006

				Plant		Seed		
Acc. no.	Origin	Branch.	Fol.	Ht. (cm)	Wdth. (cm)	Mat.	No.	100 sd. wt. (g)
2004								
204366	Thailand	5	1	110	150	1	1750	1.92
246379	Zaire	5	1	180	140	9	9339	1.86
271140	India	5	1	140	150	5	3758	1.58
279694	Mexico	5	1	180	150	5	5263	1.62
299503	S. Africa	1	1	140	130	5	11,280	1.79
316187	Australia	5	1	110	100	1	7887	1.76
318802	Ghana	5	1	150	200	9	2241	1.58
337525	Argentina	1	1	150	200	5		
2006								
194854	Japan	5	1	90	100	5	21,215	1.79
200812	Myanmar	5	1	120	150	1	11,900	1.71
292843	Virgin Islands	5	1	170	130	5	9034	1.46
292844	Virgin Islands	2	1	130	90	5	14,735	1.40
500709	Zambia	2	1	150	100	5	9800	1.67
509030	Argentina	3	3	80	40	5	12,353	1.73
Std. error		0.44	0.14	8.30	11.45	0.65	1382.11	0.03
CV (%)		43	47	23	33	52	56	9

Acc. no., accession number; Branch., branching; Fol., foliage; Ht., height; Wdth., width; Mat., maturity; sd. wt., standard weight; Std. error, standard error; CV, coefficient of variation.

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Table 2. Morphological and reproductive traits of *Senna* species regenerated in 1996, 2002 and 2004–2007

					Plant		Seed		
Species	Acc. no.	Origin	Branch.	Fol.	Ht. (cm)	Wdth. (cm)	Mat.	No.	100 sd. wt. (g)
1996									
Senna corymbosa	PI 279709	US	1	1	14	24	9	12,283	1.52
2002									
Senna angulata	PI 322312	Brazil	7	6	37	110	–	1114	1.53
2004									
Senna alata	PI 322311	Brazil	5	1	200	285	9	7424	3.25
2005									
Senna alexandrina	PI 642024	US	5	5	45	25	5	1215	1.45
Senna uniflora	PI 288247	Mexico	1	1	60	60	9	1377	1.13
2006									
Senna corymbosa	PI 214042	India	5	3	70	70	5	11,276	1.44
Senna covesii	PI 288246	Mexico	3	2	50	60	5	6779	0.19
2007									
Senna corymbosa	PI 372199	Uruguay	5	1	110	120	9	1018	2.63

Acc. no., accession number; Branch., branching; Fol., foliage; Ht., height; Wdth., width; Mat., maturity; sd. wt., standard weight; Std. error, standard error; CV, coefficient of variation.

of the *Senna* species produced an average 100 seed weight of 1.62 g.

The relatively low variability observed among coffee senna populations for the traits studied suggests a need for further strengthening of the germplasm collection as well as additional evaluations in multiple locations and years. Future studies could implement the use of molecular marker technology as well to explore the available *Senna* resources for identification of genotypes carrying the desired traits efficiently and correctly.

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References

Chomnawang MT, Surassmo S, Nukoolkarn VS and Gritsanapan W (2005) Antimicrobial effects of Thai medicinal plants against acne-inducing bacteria. *Journal of Ethnopharmacology* 101: 330–333.

ILDIS (1994) Plants and their constituents. In: Bisby FA *et al.* (eds) *Phytochemical Dictionary of the Leguminosae*. New York: Chapman & Hall, pp. 1–748.

Martin DE, Blum R, Doto J, Galbraith H and Ballow C (2007) Multiple-dose pharmacokinetics and safety of bevirimat, a novel inhibitor of HIV maturation, in healthy volunteers. *Clinical Pharmacokinetics* 46: 589–598.

National Plant Germplasm System (2008) Germplasm Resources Information Network (GRIN). Database Management Unit (DBMU), National Plant Germplasm System. US Department of Agriculture, Beltsville, MD.

Nothlings U, Murphy SP, Wilkens LR, Henderson BE and Kolonel LN (2007) Flavonols and pancreatic cancer risk: the multiethnic cohort study. *American Journal of Epidemiology* 166: 924–931.

Qian K, Nakagawa-Goto K, Yu D, Morris-Natschke SL, Nitz TJ, Kilgore N, Allaway GP and Lee KH (2007) Anti-AIDS agents 73: structure-activity relationship study and asymmetric synthesis of 3-*O*-monomethylsuccinyl-betulinic acid derivatives. *Bioorganic and Medicinal Chemistry Letters* 17: 6553–6557.

Smith PF, Ogundele A, Forrest A, Wilton J, Salzwedel K, Doto J, Allaway GP and Martin DE (2007) Phase I and II study of the safety, virologic effect, and pharmacokinetics/pharmacodynamics of single-dose 3-*o*-(3′,3′-dimethylsuccinyl) betulinic acid (bevirimat) against human immunodeficiency virus infection. *Antimicrobial Agents and Chemotherapy* 51: 3574–3581.