

## Six cultivars of *Solanum macrocarpon* (Solanaceae) in Ghana

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### ABSTRACT

The *Solanum macrocarpon* complex (the cultivated egg plant) has been studied in Ghana using morphological and experimental methods. Six cultivars belonging to the *S. macrocarpon* complex have been recognized and described. The cultivars are *S. macrocarpon* 'Gboma', *S. macrocarpon* 'Mankessim', *S. macrocarpon* 'Akwaseho', *S. macrocarpon* 'Kade', *S. macrocarpon* 'Sarpeiman' and *S. macrocarpon* 'Bui'. The very spiny, hairy plant traditionally called *S. dasyphyllum* is regarded as the wild ancestor from which the cultivars have been derived through a process of crop evolution. The variation within *S. macrocarpon* complex is attributable to genotypic differences and environmental factors.

### UITTREKSEL

Die *Solanum macrocarpon*-kompleks (die gekweekte eierplant) is in Ghana bestudeer deur gebruik te maak van morfologiese en eksperimentele metodes. Ses kultivars wat aan die *S. macrocarpon*-kompleks behoort, is erken en beskryf. Die kultivars is *S. macrocarpon* 'Gboma', *S. macrocarpon* 'Mankessim', *S. macrocarpon* 'Akwaseho', *S. macrocarpon* 'Kade', *S. macrocarpon* 'Sarpeiman' en *S. macrocarpon* 'Bui'. Die baie doringrige, harige plant wat tradisioneel *S. dasyphyllum* genoem word, word as die wilde voorouer waaruit die kultivars deur 'n proses van gewas-evolusie ontstaan het, beskou. Die variasie binne die *S. macrocarpon*-kompleks kan toegeskryf word aan genotipiese verskille en omgewingsfaktore.

### INTRODUCTION

*Solanum macrocarpon* L. is an important native African vegetable, especially in west Africa where both the leaves and fruits are eaten. In east Africa, particularly Uganda, it is however a minor crop and it is mainly the leaves that are eaten (Bukenyi 1984). The crop is also cultivated in South America and Asia. It was introduced to Europe from India, described and illustrated by Miller (1759) and named by Linnaeus (1771).

Despite its importance as a vegetable and its widespread occurrence, little has been done until now to recognize and describe any of the cultivars.

### METHODS AND MATERIALS OF MORPHOLOGICAL STUDY

Materials belonging to the *S. macrocarpon* complex were collected from different localities throughout southern Ghana, and also (mainly seeds) obtained from elsewhere in Africa (Togo, Nigeria and Uganda). In southern Ghana, farms where *S. macrocarpon* is grown, were visited. Herbarium specimens were made. Ripe fruits, from which seeds were later extracted, were collected from farms and in some cases from markets. Occasionally, when mature fruits were not available, transplants were collected and later replanted in an experimental garden. Photographs of flowering and fruiting plants were taken.

Each individual (transplant) or each fruit was given a different accession number. In the laboratory, seeds from different accessions were extracted and spread on paper to dry at room temperature. After drying a mini-

mum of 20 seeds from each accession (fruit), they were sown in compost soil in seed pots. Pots were housed in a greenhouse at a mean daily maximum temperature of 34,8 °C and mean daily minimum temperature of 22,1 °C. Pots were watered every two to three days. When seedlings were at the three-leaved stage (about two weeks after germination), they were picked out of the seed pots and transferred to seed boxes kept outside in sunshine. When the plants were about a month old they were removed from the seed boxes and planted in the experimental garden.

About ten plants of each accession were planted. The plots were constantly weeded and plants watered when necessary. The major pests of the plants (caterpillars) were controlled by spraying with DDT (Five grammes of powder in about four litres of water).

The morphological characteristics of the plants were observed in their developmental process. When plants had fully grown, measurements of the characters of stem, leaves, flowers and fruits were taken.

The following accessions were studied:

#### *S. macrocarpon* 'Gboma'

Hall & Bukenyi S32 & S35 (Ghana, Pamprouse, nr Achimota); Hall & Bukenyi S34 (Ghana, Sarpeiman, nr Achimota); Hall & Bukenyi S39 (Ghana, Avenor, nr Accra); Hall S54 (Togo, Lome); Hall S55 (Togo, Klevé); Hall S56 (Nigeria, Lagos Campus); Hall & Bukenyi S58, (Ghana, Accra market); Hall 47172 (Ghana, Medina, nr Accra).

#### *S. macrocarpon* 'Mankessim'

Hall & Bukenyi 47124 (Ghana, Mankessim); Hall 47170 & 47171 (Ghana, Nkwanta village).

#### *S. macrocarpon* 'Akwaseho'

Hall & Bukenyi S21 (Ghana, Akwaseho, Kwahu).

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*S. macrocarpon* 'Kade'

Hall 47169 (Ghana, Kade).

*S. macrocarpon* 'Sarpeiman'

Hall &amp; Bukenya S45 &amp; S47 (Ghana, Sarpeiman).

*S. macrocarpon* 'Bui'

Hall &amp; Swaine 46212 (Ghana, Bui N. P.); Sobey 45080 (Ghana, Mole Game Reserve).

*S. dasyphyllum* var. *dasyphyllum* (the putative wild ancestor)

Anoff s.n. (Ghana, Nsawam); Morton 7484 (Ghana, nr Gambaga); Katende UG. 2 (Uganda, Kampala).

The above specimens were deposited in University of Ghana Herbarium.

## RESULTS

A summary of morphological measurements is given in Tables 1–4.

TABLE 1.—Summary of means of leaf characters. Each figure represents a mean of no less than 20 measurements

	Length (mm)	Width (mm)	L/W	No. of lobes	Leaf lobe depth ÷ leaf width	Leaf length ÷ petiole length
<i>S. macrocarpon</i> 'Gboma'	279	186	1,5	5	0,2	9,6
<i>S. macrocarpon</i> 'Mankessim'	270	150	1,8	4	0,3	16,1
<i>S. macrocarpon</i> 'Akwaseho'	353	237	1,5	8	0,2	35,0
<i>S. macrocarpon</i> 'Kade'	260	156	1,7	4	0,5	31,0
<i>S. macrocarpon</i> 'Sarpeiman'	275	148	1,9	4	0,1	8,9
<i>S. macrocarpon</i> 'Bui'	210	180	1,1	4	0,4	7,7
<i>S. dasyphyllum</i> var. <i>dasyphyllum</i> (putative wild ancestor)	198	145	1,4	5	0,4	26,0

TABLE 2.—Summary of means of mature fruit characters (mm). Each figure represents a mean of no less than 20 measurements

	L	W	L/W	Calyx length	Calyx width	Calyx L/W
<i>S. macrocarpon</i> 'Gboma'	38	48	0,80	31	13	2,6
<i>S. macrocarpon</i> 'Mankessim'	45	55	0,82	25	14	1,8
<i>S. macrocarpon</i> 'Akwaseho'	54	88	0,60	91	32	2,8
<i>S. macrocarpon</i> 'Kade'	50	65	0,77	30	10	3,0
<i>S. macrocarpon</i> 'Sarpeiman'	42	53	0,80	32	14	2,3
<i>S. macrocarpon</i> 'Bui'	35	40	0,88	25	10	2,5
<i>S. dasyphyllum</i> var. <i>dasyphyllum</i> (putative wild ancestor)	37	42	0,88	27	12	2,3

TABLE 3.—Summary of means of inflorescence characters. Each figure represents a mean of no less than 20 measurements

	Number of flowers	Length of axis (mm)	Length of peduncle (mm)	Length of pedicel (mm)
<i>S. macrocarpon</i> 'Gboma'	4	8,9	0,5	15,1
<i>S. macrocarpon</i> 'Mankessim'	5	11,7	0	7,7
<i>S. macrocarpon</i> 'Akwaseho'	8	—	—	—
<i>S. macrocarpon</i> 'Kade'	3	0,6	0,6	28,7
<i>S. macrocarpon</i> 'Sarpeiman'	6	10,5	0	49,0
<i>S. macrocarpon</i> 'Bui'	5	5,0	0	6,5
<i>S. dasyphyllum</i> var. <i>dasyphyllum</i> (putative wild ancestor)	5	8,7	0	14,7

TABLE 4.—Summary of means of characters of hermaphrodite flowers (mm). Each figure represents a mean of no less than 20 measurements

	Calyx Length	Calyx width	Calyx L/W	Corolla length	Corolla L/W	Anther length	Style length
<i>S. macrocarpon</i> 'Gboma'	16,0	6,0	2,7	25,0	1,6	6,5	8,0
<i>S. macrocarpon</i> 'Mankessim'	23,0	6,0	4,0	22,0	1,6	7,0	—
<i>S. macrocarpon</i> 'Akwaseho'	60,0	30,0	2,0	30,0	—	—	—
<i>S. macrocarpon</i> 'Kade'	29,5	5,5	5,4	27,5	—	10,0	10,5
<i>S. macrocarpon</i> 'Sarpeiman'	11,5	6,5	2,0	20,5	1,8	6,0	8,0
<i>S. macrocarpon</i> 'Bui'	10,0	5,0	2,0	15,0	—	6,0	9,0
<i>S. dasyphyllum</i> var. <i>dasyphyllum</i> (putative wild ancestor)	11,5	4,5	2,6	18,0	1,9	6,5	8,5

## DISCUSSION AND CONCLUSIONS

The results of morphological study show that there is tremendous variation within the *S. macrocarpon* complex. Some of the accessions within the complex have big, deeply lobed leaves while others have small and less lobed leaves. Also flowers vary in their size and depth of corolla lobing. Whereas the flower calyx length of many accessions was 10–22 mm, one accession had a calyx length of about 60 mm; whereas the ratio between lamina length and petiole length of many accessions was 8–10, a ratio of 25–46 was obtained in one accession.

Apart from the above morphological variation, considered to be due mainly to genotypic differences, environmental factors were also seen to play a significant part in the phenotypic variation in the *S. macrocarpon* complex. One such factor was noted to be cultivation methods. For example, at Avenor near Accra in Ghana, *S. macrocarpon* was seen to be grown in crowded rows and the leaves were removed constantly for sale when the plants were still young. Figure 1 shows a typical planting of *S. macrocarpon* on a farm at Avenor. The plants here had a height of less than 0,3 m, and they had small fruits (30–35 mm diam.) and small leaves (170 × 90 mm). When seeds collected from a farm at Avenor were grown in our experimental farm with proper spacing of plants and no trimming, the plants attained a height of about 0,7 m with a fruit diameter of 40–60 mm and a mean leaf size of 255 × 164 mm.



FIGURE 1.—A typical planting of *Solanum macrocarpon* on a farm at Avenor near Accra, July 1979.

It was Bitter (1923) who first realized the tremendous variation within the *S. macrocarpon* complex and he described several infraspecific taxa. He also noted that the traditional separation of *S. macrocarpon* from *S. dasyphyllum* on the basis of the latter being spiny and hairy and the former unarmed and glabrous, was not satisfactory. He was for example able to describe, 'a spineless variety of *S. dasyphyllum* and a spiny subspecies of *S. macrocarpon*'.

We noted that there was a continuous range of variation in hairiness and spininess from very hairy and spiny accessions to glabrous and unarmed accessions. It also appears that spininess is a heterozygous character. This was demonstrated by the fact that when seeds from a single fruit (*Katende UG.1* — *S. macrocarpon*) were sown, about 60 % of the plants that grew were spiny and 40 % not spiny. Some plants of accession *Hall 47172* (*S.*

*macrocarpon*) from Medina near Accra, were seen to bear spines, though *S. macrocarpon*, according to most authors, is non-spiny.

The type specimen of *S. macrocarpon* is *Thonning 117* from Guinea [Ghana]. We have studied the IDC microfiche photographs of two duplicates on IDC microfiche No. 2203–101: III. 3–6. The specimen illustrated in III. 3 is glabrous, leaves oblong and subentire and that in III. 5 is glabrous, leaves oblong. Some of the leaves on this specimen are subentire while others are more or less deeply double-lobed with major lobes bearing minor lobes. The type specimens for *S. dasyphyllum*, *Thonning 144*, came from 'Guinea' (i.e. near Accra, Ghana (Hepper 1976). The IDC microfiche photographs (No. 2203–102: I. 1–4) show that the plants have oblong, deeply double-lobed leaves. They are very hairy and the stem, midribs and primary lateral nerves bear robust spines.

Bitter (1923) and recent other workers like Heine (1963) realized that the two species are very close.

Bukenya (1980 in unpublished M.Sc. thesis) concluded that the species traditionally called *S. macrocarpon* and *S. dasyphyllum* were one and proposed to sink the latter under *S. macrocarpon*.

In this paper we have treated the *S. macrocarpon* complex as a combination of the former two species, i.e. *S. macrocarpon* L. and *S. dasyphyllum* Schum. & Thonn.

Our study has enabled us to identify seven groups belonging to the *S. macrocarpon* complex. Since this complex is basically a cultivated crop, it is not satisfactory to give formal taxonomic ranks to these groups. We have therefore decided to give cultivar names to all these groups, except one which is wild. The wild one matches Bitter's *S. dasyphyllum* var. *dasyphyllum* in its dense spines and hairs and double lobing of the leaves. We believe that this wild plant is the ancestor of the cultivars and that the cultivars have arisen after a long process of cultivation and selection for non-spininess and non-hairiness. The name cultivar is used in this context in the same sense as used in the International Code of Nomenclature for Cultivated Plants of 1969.

The cultivar names are either the Ghanaian native names for the plants or names of localities where the cultivars were collected in Ghana. An attempt was made to compare the present cultivars with the taxa that Bitter (1923) described in Series *Macrocarpon*.

The following are the named cultivars with their descriptions and illustrations, where possible.

#### 1. *S. macrocarpon* 'Gboma' (Figure 2)

Plant of low growth, not spiny. *Flowers* and *calyx* small; calyx 15–18 × 4–6 mm. *Leaves* petiolate, more or less glabrous, occasionally with a few scattered simple hairs, very shallowly lobed, middle lobe 20–40 mm long. *Stem* glabrous. *Fruit* medium-sized, 30–40 × 40–50 mm, green or white when young, turning purplish later; yellow when ripe. *Locality*: Ghana, Avenor near Accra, 5°33'N, 0°13'W, *Hall & Bukenya S39*.

This cultivar is comparable to Bitter's *S. macrocarpon* var. *macrocarpon* (var. *culvum*). Type: Guinea [Ghana], Thonning 117.



FIGURE 2.—*Solanum macrocarpon* 'Gboma', growing at Legon, Ghana (Mar. 1980), showing rotata corolla.

### 2. *S. macrocarpon* 'Mankessim' (Figure 3)

Plants fairly tall, spiny or unarmed. *Calyx* fairly large, 20–25 × 6 mm. *Leaves* more or less subsessile, fairly deeply lobed, middle lobe 40–60 mm long, puberulous with simple, sessile stellate and stalked stellate hairs. *Stem* with same pubescence as leaves. *Fruit* fairly large, 40–50 × 50–60 mm, white when young, yellow when ripe.

*Locality:* Ghana, Mankessim, 5°16'N, 1°01'W, Hall & Bukenya 47124.

This cultivar is comparable to Bitter's *S. macrocarpon* var. *primovestitum* except that 'Mankessim' may bear spines which are lacking in var. *primovestitum* and the former has more and persistent hairs. The locality of Bitter's *S. macrocarpon* var. *primovestitum* is on the coast of Mozambique.



FIGURE 3.—*Solanum macrocarpon* 'Mankessim', growing on a farm at Mankessim, Ghana (July 1979).

### 3. *S. macrocarpon* 'Akwaseho' (Figure 4)

Plants similar to 'Mankessim', spiny or not spiny, but leaves more deeply lobed, middle lobe up to 70 mm long and fruits larger: about 50 × 90 mm. *Leaves* subsessile with some simple and sessile stellate hairs. *Calyx* very big, up to 60 × 30 mm. *Fruits* ivory-coloured when young, turning yellow when ripe.

*Locality:* Ghana, Akwaseho, 6°37'N, 0°49'W, Hall & Bukenya S21.

This cultivar is comparable to Bitter's *S. macrocarpon* var. *macrocarpon* forma *megistocalyx* Bitter, in the form of the big calyx. The calyx of our cultivar is even bigger than in forma *megistocalyx*. The major difference is that 'Akwaseho' has some sessile stellate hairs and spines may be present on leaves while forma *megistocalyx* lacks hairs and spines. The locality of forma *megistocalyx* was Congo (Lower Zaire) Region, Kisantu, Gillet s.n.



FIGURE 4.—*Solanum macrocarpon* 'Akwaseho', growing in an experimental plot at Legon, Ghana (Nov. 1979), showing big fruits, big fruiting calyx and deeply lobed leaves.

### 4. *S. macrocarpon* 'Kade' (Figure 5)

*Leaves* very narrow and deeply lobed, middle lobe up to 80 mm long; subsessile with simple, sessile stellate or stalked stellate hairs. *Calyx* fairly long but narrow, up to 30 × 60 mm. *Fruit* ovoid or spherical, 30–70 × 40 mm, green or green with patches when young, turning yellow when ripe.

*Locality:* Ghana, Abodon, 6°26'N, 1°32'W, Hall 47169.

This cultivar does not match any of Bitter's taxa. It is unique in that its leaves are so narrow and deeply lobed and it may have an oblong fruit which is unusual in *S. macrocarpon*.



FIGURE 5.—*Solanum macrocarpon* 'Kade', growing on a farm at Abodon, Ghana (July 1979).

### 5. *S. macrocarpon* 'Sarpeiman' (Figure 6)

Plants similar to 'Gboma' but almost always spiny and fairly hairy with simple, branched, sessile stellate and

stalked stellate hairs on leaves and stem. *Leaves* petio-  
late. *Fruit* green when young, turning yellow when ripe.

*Locality:* Ghana, Sarpeiman, 5°43'N, 0°18'W, Hall &  
Bukanya S45.

This cultivar is comparable to Bitter's *S. dasyphyllum*  
var. *semiglabrum* (C. W. Wright) Bitter, except that in  
the former the spine length on the midrib ranges from  
0–13 mm whereas in the latter the range is 6–10 mm.  
The type locality of *semiglabrum* is Nupe-Benue Pro-  
vince in northern Nigeria.



FIGURE 6.—*Solanum macrocarpon* 'Sarpeiman', growing in an experimental plot at Legon, Ghana (Nov. 1979) showing spines.

#### 6. *S. macrocarpon* 'Bui'

Plants spiny. *Leaves* sessile and deeply lobed, middle lobe 60–70 mm long; with sparse, simple, branched, sessile or stalked stellate hairs. *Stem* with similar pubescence as leaves but denser. *Fruit* green when young, turning yellow when ripe.

*Locality:* Ghana, Bui, 8°16'N, 2°16'W, Hall & Swaine 46212.

This cultivar is comparable to Bitter's *S. dasyphyllum* var. *dasyphyllum* except that the former is less hairy than the latter, probably because the former is occasionally cultivated. Bitter's locality of var. *dasyphyllum* is Guinea [Ghana], Thonning 144.

#### 7. Putative wild ancestor (Figure 7)

Plants very hairy and very spiny. *Leaves* sessile, often doubly lobed; middle lobe up to 60 mm long. *Ca-*



FIGURE 7.—Putative wild ancestor (*Solanum dasyphyllum* var. *dasyphyllum*) from Uganda, growing in cultivation at Legon, Ghana (Mar. 1980), showing mature, deeply lobed leaf with numerous spines and hairs.

*lyx* about 10 × 5 mm. *Leaves* and *stem* with simple, branched, sessile or stalked stellate hairs. *Fruit* green when young, turning light yellow when ripe.

*Locality:* Uganda, near Kampala, Katende UG.2; Ghana, Nsawam, Anoff s.n.

This is comparable to Bitter's *S. dasyphyllum* var. *dasyphyllum* from Guinea [Ghana] Thonning 144.

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