

Project 9. Collaborative research and networks for vegetable production

The objectives of Project 9 are to increase the capacity of national agricultural research and extension systems (NARES) to perform regional collaborative research, and to enhance the adoption and impact of research innovations. To this end, AVRDC fosters and supports effective regional and inter-regional research collaboration. In particular, the Center facilitates this collaboration using participatory research planning methods, and engages directly in collaborative research with NARES partners and advanced laboratories.

Project Coordinator: G Kuo

AVRDC-ROC cooperative program

Regional yield trials

The purpose of regional yield trials (RYTs) is to serve as one of the means for transferring AVRDC's research outputs to Taiwan. In cooperation with Taiwan national agricultural research and extension system (NARES), RYTs were conducted to evaluate promising AVRDC lines/varieties in the field under seasons and/or locations in Taiwan.

Vegetable soybean

Nine lines, including three AVRDC lines, three Tainan District Agricultural Improvement Station (DAIS) lines, and three Kaohsiung DAIS lines were evaluated against three check varieties, Kaohsiung No. 1 (KS#1), KS#2, and KS#5 at AVRDC headquarters. The lines were evaluated in four seasons: Autumn 2000 (September 15–November 28, mean day/night air temperatures at 30.1/21.5°C, 90 mm rainfall); Spring 2001 (February 7–May 3, mean day/night air temperatures at 27.4/18.1°C, 104 mm rainfall); Autumn 2001 (September 3–December 3, mean day/night air temperatures at 29.8/20.5°C, 523 mm rainfall); and Spring 2002 (February 6–Apr. 29, mean day/night air temperatures at 28.3/18.6°C, 2 mm rainfall). The experimental design was randomized complete block design (RCBD) with four replications. Plot size was 5 m × 3 m, and spacing was 50 cm between rows and 10 cm between plants.

Tested lines showed significant differences in graded pod yields (Table 122). An AVRDC line, GC93032-2-

1-1-1 produced the highest yield in Spring 2001 (9.4 kg/ha), and tied another AVRDC line, GC92001-P-25-1, for highest overall mean yield across all seasons (7.0 kg/ha). In some cases the performance of lines varied tremendously from season to season. For example, GC93010-1-1-2-2-6 produced the highest yield in Spring 2002, but the lowest yield in Spring 2001. Similarly, TS87-S4, a Tainan DAIS-developed line, produced the highest yield in Autumn 2000 but the lowest yield in Autumn 2001. Graded pod yields of spring trials were generally higher than those of fall trials. Yields in Autumn 2001 were reduced due to typhoon and heavy rain for two weeks after sowing.

Table 122. Graded pod yield (t/ha) of vegetable soybean lines tested in regional yield trials at AVRDC

Lines	Autumn 2000 ¹	Spring 2001 ²	Autumn 2001 ³	Spring 2002 ⁴	Mean
KVS968	4.6	5.9	5.0	6.8	5.6
KVS1027	6.1	5.4	4.9	7.4	6.0
KVS1159	5.1	6.0	4.1	7.1	5.6
TS85-06V	4.6	5.4	3.0	6.3	4.8
TS87-S4	6.9	6.5	2.8	6.2	5.6
TS87-12V	5.8	8.0	5.2	8.4	6.9
GC92001-P-25-1	6.1	7.9	5.0	9.1	7.0
GC93010-1-1-2-2-6	4.8	4.6	7.2	9.3	6.5
GC93032-2-1-1-1	6.2	9.4	4.2	8.3	7.0
KS#1 (ck)	6.7	6.7	3.3	5.9	5.7
KS#2 (ck)	5.7	7.8	5.8	6.5	6.5
KS#5 (ck)	4.4	5.9	3.1	7.0	5.1
Mean	5.6	6.6	4.5	7.4	6.0
LSD (5%)	0.9	1.2	0.9	1.8	

¹ Lines sown on 15 September and harvested 21–28 November 2000

² Lines sown on 7 February and harvested 26 April to 3 May 2001

³ Lines sown on 3 September and harvested 23 November to 3 December 2001

⁴ Lines sown on 6 February and harvested 19–29 April 2002

Protein percentages for the various lines ranged from as low as 36.8% for check KS#1 in Spring 2002 to a peak of 50.0% for GC93032-2-1-1-1 in Autumn 2000 (Table 123). Differences of protein content appeared to be greater between seasons than among varieties of the same season. Soluble solids is a key trait for consumer acceptability and KS#1 had the

Table 123. Quality analysis of vegetable soybean lines tested in regional yield trials at AVRDC

Lines	Autumn 2000			Spring 2001			Autumn 2001			Spring 2002			Mean		
	Protein (%)	Sugar (%)	Color ¹	Protein (%)	Sugar (%)	Color	Protein (%)	Sugar (%)	Color	Protein (%)	Sugar (%)	Color	Protein (%)	Sugar (%)	Color
KVS968	47.9	12.5	3.9	47.3	13.8	3.5	42.0	10.8	4.5	42.0	9.0	4.6	44.8	11.5	4.1
KVS1027	48.0	10.6	3.7	47.8	12.0	4.0	40.6	12.0	3.4	41.0	8.1	4.0	44.4	10.7	3.8
KVS1159	44.5	10.8	3.8	43.1	12.9	4.0	37.9	11.4	4.7	39.2	8.0	4.9	41.2	10.8	4.4
TS85-06V	49.2	13.5	3.8	47.3	14.4	3.8	40.7	12.4	3.8	42.0	10.0	4.3	44.8	12.6	3.9
TS87-S4	46.4	12.7	3.8	45.1	13.1	3.7	39.3	10.9	3.7	39.6	9.6	3.7	42.6	11.6	3.7
TS87-12V	48.6	11.2	3.8	46.3	13.1	3.6	41.0	12.2	3.5	42.6	9.9	3.4	44.6	11.6	3.6
GC92001-P-25-1	47.1	11.3	4.0	46.7	12.9	4.0	38.3	13.4	4.0	39.2	9.7	4.7	42.8	11.8	4.2
GC93010-1-1-2-2-6	48.4	10.7	3.7	46.3	12.5	3.7	40.7	12.7	3.4	42.5	8.7	4.2	44.5	11.2	3.8
GC93032-2-1-1-1	50.0	12.1	3.6	46.7	13.0	3.8	40.9	12.1	3.4	42.9	9.2	4.7	45.1	11.6	3.9
KS#1 (ck)	45.6	12.3	3.9	43.1	15.0	3.5	35.7	14.7	3.5	36.8	11.0	4.4	40.3	13.3	3.8
KS#2 (ck)	48.2	10.4	3.8	45.1	12.0	3.7	39.8	12.5	2.8	41.2	9.5	3.0	43.6	11.1	3.3
KS#5 (ck)	47.4	11.3	4.0	46.8	12.7	3.6	38.4	13.1	2.8	41.2	10.1	3.9	43.5	11.8	3.6
Mean	47.6	11.6	3.8	46.0	13.1	3.7	39.6	12.3	3.6	40.8	9.4	4.1	43.5	11.6	3.8
LSD (5%)	0.9	0.9	0.2	1.1	0.7	0.2	0.8	0.6	0.4	0.8	0.9	0.4			

¹Pod color rated on 1–6 scale with 1 = very dark green-yellow, and 6 = pale green-yellow

highest percentage of soluble solids in Spring 2001, Autumn 2001, and Spring 2002.

Another important trait is color value, with lower values signifying darker colored pods and greater consumer acceptability. Line KS#2 produced the darkest green pods, while KVS1159 consistently produced the palest pods. High yielding lines GC920001-P-25-1 and GC93032-2-1-1-1 also produced paler, less attractive pods than check varieties.

The principal criteria for selecting lines for release are higher soluble solids and lower pod color value than the check varieties. Although GC93032-2-1-1-1 produced higher yield in three seasons, it generally had lower soluble solids and paler pods than the check varieties. In fact, none of the experimental lines were superior to the check varieties for these pod quality traits.

In a separate trial, 10 new vegetable soybean lines, including two AVRDC lines, five Kaohsiung DAIS lines, and three Tainan DAIS lines, were evaluated in regional yield trials at AVRDC headquarters in Autumn 2002 (3 September to 21 November, mean day/night air temperatures at 31.9/22.6°C, 84 mm rainfall). A Kaohsiung DAIS-developed line, KVS1175, produced the highest graded pod yield, and significantly outyielded the check varieties, KS#1, KS#2, and KS#5 by 60.9%, 60.1%, and 31.5%, respectively (Table 124). KVS1175 gave significantly higher 100-fresh seeds weight than

KS#1. TS88-57V had heavier single pod than other entries. Pod length and width of all tested lines were between 4.4–5.3 cm and 1.3–1.4 cm, respectively. GC95106-6 had significantly longer pods than KS#1, KS#2 and KS#5. Three more RYT's are being planned in 2003–2004.

Table 124. Regional yield trial of vegetable soybean at AVRDC

Lines	Days to maturity	100-fresh			Graded	
		Pod no./ 500 g	seed wt. (g)	Pod length ¹ (cm)	Pod width ¹ (cm)	pod yield (t/ha)
KVS1175	73	163.7	74.3	4.4	1.3	10.3
KVS1194	74	164.3	68.0	4.5	1.4	7.6
KVS1209	74	172.0	63.0	4.5	1.4	5.5
KVS1249	73	175.0	63.0	4.6	1.3	8.5
KVS1312	72	171.3	64.3	4.7	1.3	9.4
TS88-04V	72	169.3	69.0	4.8	1.4	8.7
TS88-31V	71	178.0	63.0	5.0	1.3	5.7
TS88-57V	71	157.0	68.3	5.0	1.4	5.7
GC95004-2-3-1-1	67	159.0	67.7	5.2	1.3	8.9
GC95106-6	67	160.0	72.0	5.3	1.4	8.1
KS#1 (ck)	65	166.7	64.7	4.7	1.4	6.4
KS#2 (ck)	65	164.3	72.0	4.8	1.4	6.4
KS#5 (ck)	65	168.3	76.0	4.7	1.3	7.8
Mean	69.9	166.8	68.1	4.8	1.4	7.6
LSD (5%)	1.1	8.4	6.1	0.2	0.1	1.2

Lines sown on 3 September and harvested 12–21 November 2002

¹Measured from double-seeded pods

Fresh market tomato

This trial was conducted to identify promising fresh market hybrids with late blight resistance for mid elevation (about 500 m above sea level) farms in central Taiwan. This elevation is favorable for summer tomato production because of its relatively cool temperature; however, the high humidity is conducive to late blight infection. Five AVRDC hybrids were evaluated along with check varieties, Taoyuan-ASVEG No. 9, Taichung-ASVEG No. 10, and Farmers 301 (of Known You Seed Co.), during 6 May to 10 July 2002 (mean day/night air temperatures at 32.7/25.0°C, 384 mm rainfall) at AVRDC headquarters. The experimental design was RCBD with four replications. Plants were set in twin rows on raised beds with plants spaced 50 cm apart. Plot size was 5 m × 3 m, and 75 cm between rows. Applications of 90N–38.7P–74.7K–13.7Mg kg/ha of inorganic and 80N–34.4P–66.4K kg/ha of an organic fertilizer with organic matter content of 60% were applied by basal dressing during land preparation. Applications of 30N–12.9P–24.9K inorganic fertilizer were sidedressed two weeks after transplanting, one month after transplanting, and then again every month after that.

Late blight-resistant, large-fruited lines, FM TT792 and FM TT791, gave highest yields at 22.8 t/ha and 22.6 t/ha, respectively; both lines significantly outyielded the check variety Taichung-ASVEG No. 10 (18.3 t/ha) and Farmers 301 (13.4 t/ha) (Table 125). Despite relatively high air temperatures, all entries had high fruit set rates between 45.1 and 49.6%. FM TT795

had higher fruit set rate than FM TT792 and FM TT791, but the yield was lower due to smaller fruit size (54.3 g/fruit). Unfortunately, average yield levels of tested entries in this trial were much lower than expected. This was due to tomato leaf curl virus (ToLCV) infection during the flowering period.

FM TT795 had the highest soluble solids and FM TT793 had the highest color value among all lines tested. Overall, with its high yields and high solids/ acidity ratio, FM TT792 was considered as the most promising line. However, lines resistant to both late blight and ToLCV are needed for reliable yields in this region.

High lycopene cherry tomato

Cherry tomatoes, especially those varieties with high lycopene content, are gaining popularity in Taiwan. Three red cherry tomato hybrids were tested at AVRDC headquarters along with check Tainan-ASVEG No. 6. The trial was conducted from 27 February to 10 July 2002 (mean day/night air temperatures at 31.1/22.5°C, 386 mm rainfall). The experimental design was RCBD with four replications, two rows per plot, and 50 cm between plants. Plot size was 5 m × 3 m, and 75 cm between rows. Applications of 90N–38.7P–74.7K–13.7Mg kg/ha of inorganic and 80N–34.4P–66.4K kg/ha of an organic fertilizer with organic matter content of 60% were applied by basal dressing during land preparation. Applications of 30N–12.9P–24.9K inorganic fertilizer were sidedressed two weeks after transplanting, one

Table 125. Regional yield trial of fresh market tomato hybrids at AVRDC

Lines	Days to maturity	Fruit set (%)	Fruit wt. (g/fruit)	Marketable yield (t/ha)	Solids °brix	Acid ¹ (%)	Solids/ acid	Color ² (a/b)
FM TT791	81.4	49.2	67.9	22.6	5.75	0.49	11.73	1.00
FM TT792	81.2	45.6	70.5	22.8	5.88	0.49	12.00	1.15
FM TT793	83.2	47.1	52.0	18.5	5.90	0.51	11.57	1.20
FM TT794	83.6	45.1	75.1	18.2	5.38	0.49	10.98	0.96
FM TT795	83.2	49.6	54.3	20.9	6.13	0.57	10.75	0.83
Taoyuan-ASVEG No. 9	82.8	45.6	78.7	22.0	5.60	0.49	11.42	0.74
Taichung-ASVEG No. 10	83.3	45.8	68.5	18.3	5.53	0.48	11.52	1.13
Farmers 301	87.2	45.9	45.4	13.4	5.93	0.551	10.78	1.10
Mean	83.2	46.7	64.1	19.6	5.76	0.51	11.29	1.01
LSD (5%)	2.3	4.6	21.9	2.8	0.42	0.03	0.16	

Lines sown on 6 March, transplanted on 29 March, and harvested from 30 May to 10 July 2002

¹Equivalent of citric acid

²Values for a and b were measured with a chromometer using red standard surface. Immature green tomatoes have a/b ratio less than zero. The a/b ratio increases to zero and above as fruits ripen toward dark red.

month after transplanting, and then again every month after that.

The AVRDC hybrids selected for this trial set fruit under high temperatures, resist cracking, and have good flavor. CHT1127 matured earlier, produced significantly higher yields, and had significantly larger fruit weight, soluble solids, and color values than check Tainan ASVEG-No. 6 (Table 126). It is resistant to tomato mosaic virus and fusarium wilt races 1 and 2. On 3 December 2002, the ROC Council of Agriculture released CHT1127 as “Tainan ASVEG-No. 11.”

ToLCV-resistant cherry tomato

Overall yield of the above trial was depressed due to ToLCV incidence during the flowering period. Thus, a second trial was conducted to evaluate lines with ToLCV resistance. Five ToLCV-resistant red cherry tomato hybrids, namely, CHT1312, CHT1313, CHT1372, CHT1374, and CHT1358, and check variety Tainan-ASVEG No. 6 were evaluated at four locations

(AVRDC, Annan, Luenbey, and Sueishan; the latter three are within a 30-kilometer radius from AVRDC) from 9 August 2002 to 10 February 2003 (mean day/night air temperatures at 29.1/19.7°C, 211 mm rainfall). The experimental design was RCBD with four replications, two rows per plot, and 50 cm between plants. Plot size was 5 m × 3 m, and 75 cm between rows. Applications of 90N–38.7P–74.7K–13.7Mg kg/ha of inorganic and 80N–34.4P–66.4K kg/ha of an organic fertilizer with organic matter content of 60% were applied by basal dressing during land preparation. Applications of 30N–12.9P–24.9K inorganic fertilizer were sidedressed two weeks after transplanting, one month after transplanting, and then again every month after that.

The incidence of ToLCV for the CHT lines was very low (below 5%) at all four locations, whereas 74–100% of check variety plants were infected (Table 127). The CHT lines outyielded the check variety by 22–40% at AVRDC, 38–54% at Annan, and 162–194%

Table 126. Regional yield trial of cherry tomato hybrids at AVRDC

Lines	Days to maturity	Fruit set (%)	Fruit weight (g)	Marketable yield (t/ha)	Solids (°brix)	Acid ¹ (%)	Solids/acid	Color ² (a/b)
CHT1126	84.1	71.9	11.1	19.6	6.55	0.41	15.98	0.66
CHT1127	80.2	74.0	12.4	29.1	7.00	0.40	17.50	0.83
CHT1130	79.3	73.0	13.6	28.9	6.23	0.37	16.83	0.77
Tainan-ASVEG No. 6	83.6	72.6	10.5	17.8	6.63	0.41	16.17	0.74
LSD (5%)	1.2	4.7	1.4	3.2	0.47	0.03		0.16

Lines were sown on 27 February, transplanted on 20 March, and harvested from 20 May to 10 July 2002

¹Equivalent of citric acid

²Values for a and b were measured with a chromometer using red standard surface. Immature green tomatoes have a/b ratio less than zero. The a/b ratio increases to zero and above as fruits ripen toward dark red.

Table 127. Incidence of tomato leaf curl virus and fruit yields of cherry tomato hybrids evaluated at locations in southern Taiwan

Lines	AVRDC		Annan		Luenbey		Sueishan	
	Incidence (%)	Yield (t/ha)	Incidence (%)	Yield (t/ha)	Incidence (%)	Yield (t/ha)	Incidence (%)	Yield (t/ha)
CHT1312	0.0	78.9	0.5	79.7	3.7	- ²	2.1	43.7
CHT1313	0.0	73.4	2.1	73.8	2.1	-	3.1	40.6
CHT1372	0.0	71.0	2.6	71.9	1.6	-	0.5	43.4
CHT1374	0.0	72.8	1.0	71.5	4.7	-	2.1	41.0
CHT1358	0.0	81.5	2.6	71.9	1.6	-	2.6	45.5
Tainan-ASVEG No. 6	74.0	58.2	100.0	51.9	100.0	-	100.0	15.5
LSD (5%)	19.2	7.5	3.3	14.9	4.2	-	3.6	7.2

¹Lines were transplanted on 2 September at AVRDC, 11 September at Anna, 12 September in Sueishan, and 13 September 2002 in Luenbey. All lines were harvested during 30 October 2002 to 10 February 2003 across four locations.

²Yield data were unreliable.

at Sueishan. Yield data of Luenbey were not reliable due to recording errors by the collaborating farmer. Tainan-ASVEG No. 6 had higher soluble solids and lower acidity across four locations than five CHT lines, whereas CHT1372 had significantly higher color value than the check (Table 128). RYTs of these five CHT lines will be further conducted at same four locations at different seasons in 2003 to verify this observation.

Table 128. Quality analysis of cherry tomato hybrids tested in regional yield trials across four locations in southern Taiwan during summer of 2002

Lines	pH	Solids (°Brix)	Acid ¹ (%)	Solids/ acid	Color ² (a/b)
CHT1312	4.09	6.09	0.59	10.32	1.61
CHT1313	4.11	6.01	0.54	11.13	1.68
CHT1372	4.10	6.20	0.54	11.48	1.71
CHT1374	4.11	6.03	0.55	10.96	1.66
CHT1358	4.07	6.08	0.59	10.31	1.65
Tainan-ASVEG No. 6 (ck)	4.10	6.13	0.49	12.51	1.48
LSD (5%)	0.02	0.41	0.02		0.07

¹Equivalent of citric acid

²Values for a and b were measured with a chromometer using red standard surface. Immature green tomatoes have a/b ratio less than zero. The a/b ratio increases to zero and above as fruits ripen toward dark red.

Evaluation of indigenous vegetables

As one of the largest depositories of vegetable germplasm in the world, the host NARES is keen on possible utilization of AVRDC's collection, especially indigenous vegetables of tropical origin. Thus, the ROC Council of Agriculture supported a project in complementing collection efforts of AVRDC Genetic Resources and Seed Unit (GRSU) on indigenous vegetables from South and Southeast Asia. The objective of this project was to observe utilization potentials of indigenous vegetables as new vegetables in Taiwan. The effort in 2002 entails: collection of information, field testing to observe for botanical and horticultural traits, testing for adaptability and production potential, observation of potential diseases and insect pests, testing for tolerance to heat and flooding, analyses of nutrient contents and health-related factors, and evaluation of consumer acceptance.

Observational trials of indigenous vegetables

The objectives of this trial was to investigate adaptability and acceptability of lesser-known

vegetables indigenous to the tropics, and to identify promising materials in overcoming hot-wet constraints and in diversifying cropping systems and diets. An observational plot with 0.63 ha for indigenous vegetables was established in 2001–2002 at AVRDC. Materials (647 accessions, 196 species of indigenous vegetables) were obtained from GRSU and other collaborators. The promising materials were selected based on the following criteria: 1) profuse growth under hot-wet conditions; 2) less disease and insect pest infections; 3) special nutrient contribution; and 4) acceptability to taste panels.

Two hundred eighty-three of these accessions (170 species) were planted and investigated at observational plot without replication in 2001–2002. Among them, 117 accessions from 59 genera (70 species) were characterized horticulturally, and 84 accessions from 55 species were multiplied.

Eighteen species grew well during the hot-wet season: *Anredera cordifolia*, *Asystasia gangetica*, *Basella alba*, *Cassia occidentalis*, *Celosia argentea*, *Coccinia grandis*, *Corchorus olitorius*, *Curcuma longa*, *Eryngium foetidum*, *Gynura bicolor*, *Gynura crepidioides*, *Gynura oralis*, *Lablab purpureus*, *Lycium chinense*, *Momordica cochinchinensis*, *Monochoria vaginalis*, *Perilla frutescens*, and *Telosma cordata*. Among them, six species with fine taste and high nutrient content or antioxidant activity were selected for replicated yield trials (Table 129).

Table 129. Promising species with desirable nutritional properties

Species (part used)	Nutrient or functional property
<i>Cassia occidentalis</i> (shoot)	antioxidant, Vit. C, β -carotene
<i>Coccinia grandis</i> (shoot)	Ca, Fe, fiber, good texture
<i>Corchorus olitorius</i> (shoot)	Ca, Fe, β -carotene, fiber
<i>Lablab purpureus</i> (pod)	antioxidant
<i>Momordica cochinchinensis</i> (fruit)	Ca, Vit. C, fiber, sugar
<i>Telosma cordata</i> (flower bud)	Ca, Fe, fiber, sugar

Special attention was directed toward *Abelmoschus* and *Hibiscus* due to available germplasm and their promising potential for hot-wet conditions. Three hundred and thirty-seven accessions of *Abelmoschus* and 27 accessions of *Hibiscus* were planted at the AVRDC experimental farm without replication in 2001–2002. Plot size was 3 m \times 1.5 m. There were five

plants per accession per plot and 50 cm between plants. Seeds were sown on 13 March and transplanted on 3 April 2002. Fully-grown immature pods of *Abelmoschus* were harvested twice a week from three plants per plot during May to December. Three immature pods per plant were sampled during peak harvesting period for measurements of pod length and width, and ridge number. Extent of pubescence on the sampled pods was also investigated. Edible young shoots of *Hibiscus* were harvested once a week from three plants per plot from June to November.

Desirable *Abelmoschus* pod characteristics were 10–15 cm length and 1.5–2.0 cm width, five ridges, and smooth hair. Thirteen promising accessions were identified, namely TOT0581 (fully grown immature pod length of 11.4), TOT1496 (13.1), TOT1514 (12.4), TOT1767 (11.1), TOT2191 (12.4), TOT2202 (10.3), TOT2749 (12.0), TOT3133 (13.2), TOT4115 (10.5), TOT4242 (12.0), TOT4641 (12.8), TOT4719 (13.4), and TOT5864 (14.3). Five accessions (TOT1496, TOT1514, TOT2191, TOT2202 and TOT3133) produced round-shaped pods, which may generate interest in markets. Accessions TOT0581, TOT1496, TOT2191, TOT2202, TOT4242, and TOT5864 were multiplied for future trials.

For *Hibiscus*, 16 accessions were characterized and three promising accessions (TOT0534, TOT4178, and TOT4423) were identified and selected for future trials. These promising accessions possessed colorful leaves and a sour flavor preferred by an organoleptic panel.

A panel of 33 persons evaluated cooking methods, appearance before and after cooking, and taste after cooking. Nineteen promising species were investigated in 2002. Among these, *Anredera cordifolia*, *Coccinia grandis*, *Lycium chinense*, *Monochoria vaginalis*, and *Perilla frutescens*, were well accepted. Stir-frying was the preferred way to prepare the vegetables, followed by boiling. Additional studies with consumers and farmers will be implemented in 2003 to identify the most promising species for Taiwan.

Nutrient values of indigenous vegetables

Twenty-eight samples of 25 species from the aforementioned observational trials were collected. Raw materials of 1–2 kg edible portions were analyzed by the AVRDC Nutrition and Analytical Lab. Contents of protein, β -carotene, vitamin C, iron, and calcium were measured to evaluate nutritional quality while

contents of dry matter, fiber, and sugar were measured to evaluate eating quality.

Variations of nutrient values were wide, likely due to age, variety, texture and part of plant (Table 130). The rhizomes of *Curcuma longa* and leaves of *Cassia sophera* contained the highest amounts of protein (about 7.3% on a fresh weight basis). Leaves of *Cassia sophera* and young shoots of *Coccinia grandis* and *Clitoria ternatea* had the highest protein densities, over 35% on a dry weight basis, which is comparable to the protein content of soybean.

For β -carotene, *Cassia sophera* had the highest value (19.8 mg/100 g fresh weight). *Cassia tora* and *Corchorus olitorius* were also high, with values equivalent to that of carrot (about 11.5 mg). Stem and fruit types of vegetables such as eggplant, Indian nightshade, ivy gourd fruits, taro stalk, and aromatic turmeric rhizomes were relatively low in β -carotene.

Vitamin C contents were mostly below 100 mg/100 g edible portion, with the exceptions of *Cassia sophera* and *Zanthoxylum ailantoides*. Vitamin C contents of these two vegetables were outstanding in comparison to other vegetables and similar to that of chili pepper. *Cassia tora* and *Echeveria* sp. showed calcium values exceeding 300 mg/100g fresh weight, which are very high compared to vegetables commonly listed in food composition tables. In contrast to species in last year's collection, in which 7 samples out of 40 had iron content higher than 4 mg/100 fresh, this year only *Oenanthe javanica* had an iron content exceeding such level. Overall, *Cassia sophera* and *Cassia tora* were superior to other tested vegetables in nutritional quality.

With regard to eating quality, fruit and stem types of vegetables showed higher sugar densities than young shoots and leafy forms. On the other hand, fruit and leafy types showed higher fiber content on average. Regarding eating quality, sugar was considered as a positive factor, while higher dry matter and fiber were deemed as negative factors. Hence we scored overall eating quality as a value calculated as sugar divided by fiber and dry matter, with higher values indicating better eating quality. The top three vegetables based on eating values were *Colocasia esculenta* and fruit of *Lagenaria siceraria* and *Solanum mammosum*; while the worst three were fruit of *Solanum indicum* and *Solanum melongena*, and young shoots of *Hibiscus sabdariffa*. Leaves of *Cassia tora* and *Cassia sophera*, the most nutritious vegetables, rated relatively poor in eating quality, ranking 19 and 20 out of 28 types, respectively.

Table 130. Nutrient contents of indigenous vegetables collected from AVRDC Indigenous Vegetable Observational Plot in 2002

Common name	Scientific name	Portion ¹	Dry matter (g)	Fiber (g)	Sugar (g)	Protein (g)	Vit.C (mg)	β-carot. (mg)	Ca (mg)	Fe (mg)
African eggplant	<i>Solanum macrocarpon</i>	fruit	9	1.14	2.07	1.23	0.03	11	7	0.36
Ailanthus prickly-ash	<i>Zanthoxylum ailantoides</i>	leaf	26	2.13	2.67	5.69	8.43	138	95	2.41
Anisomeles	<i>Anisomeles indica</i>	leaf	20	2.20	2.08	5.16	9.21	31	21	2.43
Aromatic turmeric	<i>Curcuma longa</i>	rhizome	30	0.70	1.38	7.39	0.02	0	20	1.85
Bamboong	<i>Oenanthe javanica</i>	young shoot	8	0.96	0.86	1.81	3.52	19	194	4.23
Bottle gourd	<i>Lagenaria siceraria</i>	fruit	5	0.69	2.36	0.58	0.02	5	7	0.30
Butterfly pea	<i>Clitoria ternatea</i>	young shoot	12	2.05	0.94	4.51	8.52	117	23	1.34
Chard, dark green leaf	<i>Beta vulgaris</i>	leaf	7	0.74	1.23	1.85	2.72	17	54	0.55
Chard, light green leaf	<i>Beta vulgaris</i>	leaf	6	0.88	0.62	1.29	1.38	6	52	0.55
Chive	<i>Allium schoenoprasum</i>	leaf	10	1.46	3.12	2.46	1.51	21	92	0.50
Echeveria	<i>Echeveria</i> sp.	leaf	4	0.22	0.42	0.32	0.46	10	338	0.20
Eggplant	<i>Solanum melongena</i>	fruit	16	5.57	2.17	2.24	0.07	20	11	0.65
Estragon	<i>Artemiscus dracunculus</i>	young shoot	12	1.23	0.49	3.70	5.36	23	95	1.76
Indian nightshade	<i>Solanum indicum</i>	fruit	17	5.23	1.91	2.39	0.60	1	135	1.18
Ivy gourd	<i>Coccinia grandis</i>	young shoot	8	0.97	0.41	3.14	1.60	26	15	0.91
Ivy gourd	<i>Coccinia grandis</i>	mature fruit	32	5.37	10.42	5.44	1.40	5	105	2.06
Ivy gourd	<i>Coccinia grandis</i>	young fruit	25	4.92	4.36	4.43	0.40	17	60	1.55
Jute mallow	<i>Corchorus olitorius</i>	young shoot	18	1.52	2.03	5.96	11.94	72	198	2.36
Nipple fruit	<i>Solanum mammosum</i>	fruit	7	0.78	3.23	0.96	0.05	4	7	0.30
Oriental senna	<i>Cassia tora</i>	young shoot	16	1.44	1.02	4.97	11.43	105	346	1.39
Pong-hu senna	<i>Cassia sophera</i>	young shoot	18	1.45	1.17	7.17	19.83	291	273	2.88
Potherb fameflower	<i>Talinum triangulare</i>	young shoot	9	0.89	0.31	2.77	6.07	74	106	1.50
Roselle	<i>Hibiscus sabdariffa</i>	young shoot	11	1.30	0.42	2.62	4.40	25	217	1.26
Spiny bitter cucumber	<i>Momordica cochinchinensis</i>	young fruit	7	1.03	1.80	0.94	0.04	91	23	0.34
Taro	<i>Colocasia esculenta</i>	stalk	7	0.80	4.11	0.32	0.20	5	79	0.36
Telosma	<i>Telosma cordata</i>	flower bud	11	1.18	2.62	3.13	0.74	52	19	0.92
Tree of damocles	<i>Oroxylum indicum</i>	young shoot	20	1.29	0.92	5.92	3.48	97	26	1.26
Wedge fruit grass	<i>Sphenoclea zeylanica</i>	young shoot	10	1.08	1.65	2.72	5.36	65	115	1.61
Average			14	1.76	2.03	3.25	3.89	48	98	1.32
Standard deviation			8	1.53	1.98	2.09	4.82	62	99	0.95
Minimum			4	0.22	0.31	0.32	0.02	0	7	0.20
Maximum			32	5.57	10.42	7.39	19.83	291	346	4.23

¹100 g fresh weight of edible portion