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Preliminary study on yield performance and chemical composition of 10 locally selected *Ocimum* accessions

(Kajian awal terhadap prestasi hasil dan kandungan kimia 10 aksesi *Ocimum* daripada pemilihan tempatan)

M. Muhamad Ghawas* and A.W. Ahmad**

Key words: *Ocimum* spp., basil, clonal evaluation, herbs and essential oil yield, chemical composition

Abstrak
Sepuluh aksesi *Ocimum* terpilih dari kawasan tempatan yang menunjukkan perbezaan ciri morfologi telah dinilai bagi penentuan potensi hasil dan profil minyak pati. Perbezaan ketara dari segi hasil herba segar, hasil minyak pati dan peratus kandungan minyak pati (berasaskan herba segar) telah diperoleh. Hasil herba segar dan minyak pati di petak kecil masing-masing ialah 25.70–66.20 t/ha dan 47.44–137.69 kg/ha. Kandungan minyak pati daripada herba segar ialah 0.117–0.314%. Hasil adalah berdasarkan penuaian utama dan dua kali ratun setahun. Kandungan kimia minyak pati seperti metil kavikol, eugenol, cis-osimena, metil eugenol, linalool dan kamfor yang terdapat dalam aksesi turut dibincangkan.

Abstract
Ten locally selected *Ocimum* accessions showing differences in morphological characters were evaluated for determination of their yield potential and chemical profile. Significant differences in fresh herb and essential oil yield and oil recovery percentages were obtained among them. Fresh herb and essential oil yield from small plots ranged between 25.70–66.20 t/ha and 47.44–137.69 kg/ha respectively. Oil recovery (fresh basis) were between 0.117–0.314%. Yields were based on one main crop and two ratoons per year. The chemical constituents such as methyl chavicol, eugenol, cis-ocimene, methyl eugenol, linalool and camphor obtained from the accessions were also discussed.

Introduction

The genus *Ocimum* of the family Lamiaceae, locally known as 'selasih' and 'kemangi', is adapted to and thrive well on a variety of soils and climatic conditions favourable for vegetable production. Long days and high temperatures have been found favourable for plant growth and higher oil production (Pushpangadan and Bradu 1995). *Ocimum* can be grown up to an altitude of about 1 000 m, and requires dry, light, well-drained soil with pH 4.3 to 8.2. The plants are susceptible to both water stress and water-logging at any stage of growth (Anguiler et al. 1999).

*Rice and Industrial Crops Research Centre, MARDI Headquarters, Serdang, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia
**Technical Services Centre, MARDI Headquarters, Serdang, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia
Authors' full names: Muhamad Ghawas Maarof and Ahmad Abd. Wahab
E-mail: muga@mardi.my

Ocimum, collectively known as basil, comprises more than 30 species of herbs and shrubs from the tropical and subtropical regions of Asia, Africa and Central and South America. The main centre of diversity appears to be in Africa (Paton 1992). Basil is primarily a cross-pollinating species and many cultivars of basil are easily intercrossed (Khrisnan 1981; Nation et al. 1992). Several species of *Ocimum* can form inter-specific hybrids (Sobti and Pushpangadan 1982).

Basil has many uses. Traditionally it is used as culinary herbs, medicines and in rituals. In United States, due to its beauty and fragrance, lines are being selected as ornamentals (Mario and Simon 1996). Basil has also been long recognized as a diverse and rich source of essential oils. Essential oil extracted from the leaves and flowering tops is extensively used by the perfumery, pharmaceutical and food industries for its natural aroma and flavour (Simon et al. 1984). The oil of *Ocimum* spp. has also been shown to contain biologically-active constituents that are insecticidal (Deshpande and Tipnis 1977; Chogo and Crank 1981; Chavan and Nikam 1982), nematicidal (Chatterjee et al. 1982), fungistatic (Reuveni et al. 1984) and antimicrobial properties (Ntezurubangza et al. 1984).

In Malaysia, basil is planted in gardens of households. It is being used to flavour foods, as medicine and in rituals (Burkhill 1966). In spite of its long existence in the country, there is still no documented information as regard to their yield performance and the chemical composition of the essential oil. This evaluation is to determine the potential yield in terms of fresh herb and essential oils, to characterize the chemical profile of the essential oils of local accessions, and to select for further evaluations.

Materials and methods

Ten clonal accessions which showed vigour in growth and differences in morphological characters from observation of plants in the germplasm collection were used in the evaluation. Seven accessions (BM 01, BM 02, BM 05, BM 08, BM 10, BM 13, and BM 14) were of the species *Ocimum basilicum* or also known as sweet basil, two accessions (BM 03 and BM 11) were *Ocimum sanctum* while one accession (BM 16) was *Ocimum gratissimum.* These clones were vegetatively propagated through 3–4 leaf pairs stem cuttings. The cut was made below the fourth node from the shoot apex. One-month-old seedlings were field planted in 20 July 1999 on Rengam Series soil at MARDI Research Station in Kluang, Johor. The experimental site, previously an idle land with grasses, was about 100 m above sea level and has a mean rainfall of about 2 300 mm with no regular dry season (Nieuwolt 1982).

The experiment was laid out in a randomized complete block design with three replications. Each treatment consisted of a six-row plot with 24 plants per row. The planting distance was 30 cm within row and 60 cm between rows, giving a density of about 55 556 plants/ha. Large producers plant 70 000 to 84 000 plants/ha (Fletcher 1996). Plants were grown in the open under rainfed conditions. No nipping or pinching of flowering tops was carried out during the evaluation. Fertilizer applications depend upon soil type and cropping history. According to Simon (1995), basil responds well on moderate fertility, and a $N:P_2O_5:K_2O$ ratio of 1:1:1 can be used successfully, with a rate of 230–300 kg of actual N/ha applied as broadcast and plough down. Nitrogen side dressing at rates of 50–70 kg of N/ha were suggested following each harvest. In this evaluation, fertilizer application consisted of 5 g CIRP per planting hole as basal dressing followed by application of 15 g/plant of NPK compound (15:15:15) were carried out on the first and second months of field planting respectively, giving a total of 250 kg/ha of each N, P_2O_5 and K_2O. The same rate and timing were adapted for the first and second ratoon crops. Side dressing of N at the rate of 60 kg/ha was applied immediately after each harvest. Weed control was done manually, and no pest and disease control was carried out as there was no incidence.

Harvesting were done at full bloom stage. Individual plants was cut manually at about 15 cm from the ground level. For the main crop, depending on the clones, harvesting was carried out after 90–120 days of field planting. Subsequent harvesting, for the ratoon crops, were carried out between 92–97 days after each harvest. The biomass from each treatment plot were weighed fresh for herb yield. For determination of essential oil content, random samples weighing 20 kg from each treatment plot were distilled for 2 hours within 3 hours of harvesting, using a portable water-steam distillation unit. The recovery percentages of each treatment were obtained through calculating the volume of essential oil obtained from every unit weight of fresh herb distilled. While the oil yield was the product of fresh herb yield and the recovery percentage of the respective treatment. Analyses of variance and Duncan's Multiple Range Test (DMRT) were carried out for the parameters evaluated. Significant differences in yield production per hectare basis among the clones evaluated were used to determine their performance. Selected chemical composition of the essential oil was determined using a Gas Chromatograph-Mass Selective Detector. The yield potential and chemical content will be used as basis for further line/progeny evaluation.

Results and discussion

Significant differences in the parameters evaluated were obtained among the 10 *Ocimum* accessions. The yield of fresh herb, recovery percentages and essential oil yield were between 25.70–66.20 t/ha, 0.117–0.314% and 47.44–137.69 kg/ha respectively. The highest fresh herb production of 66.20 t/ha was obtained from BM 16. Five others (BM 02, BM 10, BM 11, BM 13 and BM 14) were not significantly different from one another *(Table 1)*.

For essential oil, BM 14 and BM 16 with yields of 136.13 kg/ha and 137.69 kg/ha respectively, gave significantly higher production as compared to the other accessions evaluated. Two others, BM 02 and BM 05 yielded 79.63 kg/ha and 103.47 kg/ha respectively. The highest average recovery percentage of the 10 local accessions evaluated was obtained from BM 14 which gave 0.314%.

Large variation in growth and yield could be expected due to climatic conditions, plant type, cultural and management practices and other related factors. According to Anguiler et al. (1999),

Table 1. Fresh herb, oil recovery (fresh weight basis) and essential oil yield of 10 locally selected *Ocimum* accessions at Kluang, Johor

Acc. no.	Fresh herb yield (t/ha)	Oil recovery (%)	Essential oil yield (kg/ha)
BM 01	25.83c	0.186cd	48.04c
BM 02	34.77bc	0.229b	79.63bc
BM 03	25.70c	0.204bc	52.43c
BM 05	46.19b	0.224b	103.47b
BM 08	26.80c	0.117cd	47.44c
BM 10	28.19bc	0.198bc	55.54c
BM 11	30.56bc	0.162de	49.51c
BM 13	41.03bc	0.138e	56.63c
BM 14	43.35bc	0.314a	136.13a
BM 16	66.20a	0.208bc	137.69a

Mean values in the same column with different letters are significantly different (p <0.05) according to DMRT yields of fresh leaves of sweet basil and essential oil range from 5–20 t/ha and 40 kg/ha respectively. In California, United States fresh leaves yield range from 15–25 t/ha (Fletcher 1996). An analysis on oil recovery (v/fresh weight) of more than 60 accessions of *Ocimum* spp. harvested during full bloom in the United States gave a range of 0.04–0.70% (Simon et al. 1990). The average yield of selected and improved strain of seven *Ocimum* spp. evaluated in India for fresh herb production, oil yield and oil recovery (fresh basis) ranged from 40–60 t/ha, 160–300 kg/ha and 0.40–0.50% respectively (Puspangadan et al. 1995).

Oil constituents partly determine the quality of essential oil. Profile of selected chemicals of the 10 *Ocimum* spp. evaluated is as shown in *Table 2*. Among the accessions evaluated methyl chavicol was highest in BM 14 (87.77%). Five other accessions (BM 01, BM 02, BM 05, BM 08, and BM 10) also showed high methyl chavicol content (60.04–82.24%). BM 16 gave the highest eugenol (33.77%) and cis-ocimene (24.60%) while BM 03 and BM 11 were high in methyl eugenol (39.42% and 45.45% respectively). The overall content of linalool was low. The highest was from BM 13 (6.03%) followed by BM 10 (4.74%).

The principal constituent of exotic basil is mainly methyl chavicol (70–88%), with small amount of linalool, cineol, camphor, eugenol, limonene and citronellol (Lawless 1992). This oil is used in the production of high class fragrances, soaps and dental products. It is also used extensively in major food categories especially meat products and savouries. It was reported by Guenther (1974) that basil oils containing no camphor is of the highest quality under the fragrance industry. In this evaluation, accessions BM 10, BM 11, BM 13 and BM 16 contained no camphor. However, the essential oil yield of BM 11 was among the lowest (49.51 kg/ha)

Based on the essential oil yield and chemical profile (high in methyl chavicol and linalool but low in camphor), seeds of six accessions namely, BM 02, BM 05, BM 10, BM 13, BM 14 and BM 16 were selected for further line evaluation.

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Table 2. Chemical profile of essential oils of 10 locally selected *Ocimum* accessions at Kluang, Johor

Acc. no.	Methyl chavicol (%)	Methyl eugenol (%)	Cis-ocimene (%)	Trans-beta ocimene (%)	1,8-cineole (%)	Eugenol (%)	Linalool (%)	Camphor (%)
BM 01	78.61	1.25	0.18	–	1.62	–	3.40	0.23
BM 02	77.02	1.55	0.17	–	1.80	–	2.36	1.27
BM 03	7.61	39.42	–	–	–	1.20	1.31	0.22
BM 05	82.24	0.96	–	1.08	1.99	–	1.06	1.11
BM 08	71.05	0.68	–	4.26	3.11	0.68	–	2.32
BM 10	60.04	8.46	–	4.64	2.53	0.36	4.74	–
BM 11	1.60	45.45	–	–	0.15	0.61	1.08	–
BM 13	3.89	6.27	–	0.80	0.25	0 55	6.03	–
BM 14	88.77	0.38	–	0.94	0.96	–	1.77	0.70
BM 16	5.15	0.50	24.60	–	–	33.77	2.31	–

– = not detectable

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