Up to date Results in Selection and Registration of "Small Seeded" Cultivars of *Foeniculum vulgare* Mill. for Large Scale Production

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Abstract

The large scale cultivation of *Foeniculum vulgare* and its taxa is going on in many countries of central and southern regions of Europe, in Asia (India, Japan, and Indonesia), Egypt, Argentina and Australia. Based on practical-technological considerations, the importance of production of "small seeded" cultivars of standard quality came into the center of interest. As a result of four years of individual selection, (1996-2000) three "small seeded" cultivar candidates (SM1, SM2, SM3) were created. In contrast to the registered cultivars, all the selected materials form a relatively small fruits and are able to fulfil the practicality requirement. The 1000 fruit mass of these new cultivars is about 3-4 g and more than 60% of their fruits can pass thorough a 2 mm size sieve. In addition, the essential oil accumulation level in the fruits of the new candidates is relatively high (6.1-7.6 ml/100 g) and the composition of the oil is in harmony with international standards. Registration of the three candidates, characterised by small seed size, was begun by the German Cultivar Registration Agency in 2002.

INTRODUCTION

Foeniculum vulgare Mill. and its related species have been utilised as medicinal plants and spices for several centuries back (Hornok, 1992). Two subspecies and three varieties of *Foeniculum vulgare* have to be distinguished (Bernáth et al., 1994, 1996). The drugs of *Foeniculum vulgare* subsp. *capillaceum* var. *vulgare* (bitter fennel) and subsp. *capillaceum* var. *dulce* (sweet fennel), are commonly known as fennel, and are authorised by most of the European and over European pharmacopoeias, including DAB 10, Ph.Helv. VII., Ph.Hg.VII., ÖAB, USP XXI. The fruit of both varieties are discussed in the ESCOP Monographs (1996) under the title "*Foeniculi fructus* - Fennel".

Based on practical technological considerations, the importance of production of "small seeded" cultivars came into the center of interest. Our idea was to take this challenge, utilising our earlier results achieved in evaluation of gene-bank collections (Bernáth et al., 1994), and select new cultivars producing relative small and uniform seeds.

MATERIALS AND METHODS

The selection of new "small seeded" cultivars was started in 1996 in Soroksár. The selection was based on plant materials taken from Hungarian, and international gene bank collections (Bernáth et al., 1996; Chung et al., 1999). A total of 40 different descendant lines of F61 and F86 gene-bank material (of German origin) and lines from cultivar 'Soroksári' (Hungarian) were investigated. As a result of 4 years long of selection, three "small seeded" populations (SM1, SM2, SM3) were created. To evaluate their characteristics, a cultivar comparison test was conducted in 2001, in Soroksár. The Hungarian cultivar 'Soroksári' and the German cv. 'Berfena' were used as standards.

The experiment was arranged into three blocks and field plots were prepared according to the cultivation practices described by Bundenssortenamts (1999). Three replications of each cultivars and "small seeded" candidates were checked. The fruits of

different cultivars and candidates were sown into propagation boxes under greenhouse conditions on 27 March, 2001. The seedlings were transplanted to field plots on the 8th of May, at the three to four leaf growth stage when plants were 1-15 cm tall. The plants were grown in rows set 1 m apart and the individuals were spaced 50 cm apart within rows. After transplanting and four times afterwards, the field plots were irrigated with 30 mm of water. Because of the appearance of a fungal infection, especially in the case of cv. 'Berfena', fungicide treatments were applied at two week intervals beginning as flowers appeared.

During the vegetation cycle morpho-phenological data was collected. On the 10th of October the plants were harvested and evaluated individually. The essential oil content and quality were analysed by water distillation and GC analysis described by us earlier (Bernáth et al., 1996, 1999).

RESULTS

Evaluation of the Height of the Plants

The stands of the three small seeded selections and the two standard cultivars (in all replications) were harvested on the 10th of October measuring data of all plants, individually. The data are presented in Table 1.

The cultivars can be well separated according to their height, measured at the time of ripening. In spite of the large variability of the individuals there is no doubt that cv. 'Soroksári' and its related candidate 'SM1' were the tallest, each averaging 112 cm in height. The cultivar 'Berfena' slows down its development earlier, which appears in its restricted height to an average of 90 cm. The candidates 'SM2' and 'SM3' were an intermediate height.

Biomass Production

The cultivar 'Soroksári' and its selected population ('SM1') have an outstanding and rather similar biomass-production capacity (an average of 331.0-361.0 g). The total biomass production capacity of cv. 'Berfena' proved to be about the half of that of 'Soroksári'. The productivity of the two other candidate 'SM2' and 'SM3' produced an average of 243.0-288.0 g values.

All cultivars were harvested as seeds ripened, resulting in a relatively early harvest of 'Berfena'. Other cultivars were harvested approximately one month after 'Berfena' was harvested.

According to the results the main goal of selecting plants with decreased fruit size of the fennel was successfully attained. As a result of four years of individual selection, (1996-2000) the original 1000 fruit mass of the initial populations was decreased successfully (Fig. 1-3). Based on the data of all populations the thousand fruit mass moved to the direction of much smaller values and stabilised there. According to the harvest data of 2001 the 1000 seed mass of traditional cultivars is above 5 g, while 'SM1' 'SM2' and 'SM3' can be characterised by 4.38, 3.96 and 3.33 g values, respectively.

In contrast to the registrated cultivars all the selected materials ('SM1' 'SM2' and 'SM3') were able to fulfill the requirement that more than 60% of their fruits can get through the 2 mm size sieve (Fig. 4). It is an interesting phenomenon that the populations of selected materials are rather homogenous in this respect.

Characterisation of the Essential Oil Accumulation

Based on the data, the essential oil accumulation in SM1 is much greater than that of SM2 or SM3, although these selections yielded an acceptable amount of oil (Table 2). According to the compositional analysis, candidate SM1 and the cultivar 'Soroksári', which is its parent population, accumulated the highest ratio of anethole. The accumulation level in SM1 was as high as 68 percent, while in 'Soroksári' the level was around 70.0 percent. Cv. 'Berfena' accumulated characteristically 10 percent less trans-anethole. SM2 and SM3 took 65 percent anethole content. In respect of methyl chavicol,

no large differences were found. Its amount was about 2.3-2.5 percent in all material investigated. The accumulation ratio of fenchone was characteristically high in cv. ‘Berfena’.

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Tables

Table 1. Production characteristics of candidates ('SM1', 'SM2' and 'SM3') and standard cultivars of fennel at time of harvest (2001).

Character	"Small seeded" candidates			Standard cultivars	
	SM1	SM2	SM3	'Berfena'	'Soroksári'
Height (cm)	112.1	102.6	94.6	89.5	112.7
min.	82.0	78.0	70.0	72.0	94.0
max.	137.0	120.0	122.0	110.0	136.0
$s^{\pm}$	15.9	17.3	17.5	13.7	15.5
Total mass (g)	361.0	288.0	243.0	154.0	331.0
min.	120.0	120.0	120.0	50.0	190.0
max.	680.0	450.0	490.0	250.0	400.0
$s^{\pm}$	167.0	134.0	133.0	78.0	73.0
Fruit mass (g)	13.8	15.0	13.7	19.3	12.5
min.	3.8	2.6	3.6	4.2	6.9
max.	22.6	30.9	27.7	28.1	24.8
$s^{\pm}$	7.1	9.8	7.6	11.6	6.9
2 mm sieve (%)	71.3	75.3	83.3	38.7	56.6
1000 fruits (g)	4.38	3.96	3.33	5.45	5.38
Essential oil %	7.6	6.1	6.7	7.9	7.8

Table 2. Main qualitative features of the essential oil distilled from different cv. candidates and that of the standard cultivars (2001).

Plant material	Main components of essential oil %		
	trans-anethole	fenchone	methyl chavicol
SM1	68.0	22.5	2.39
SM2	65.1	25.5	2.39
SM3	66.7	23.1	2.36
'Soroksári'	70.0	20.7	2.5
'Berfena'	60.5	27.7	2.2

Figures

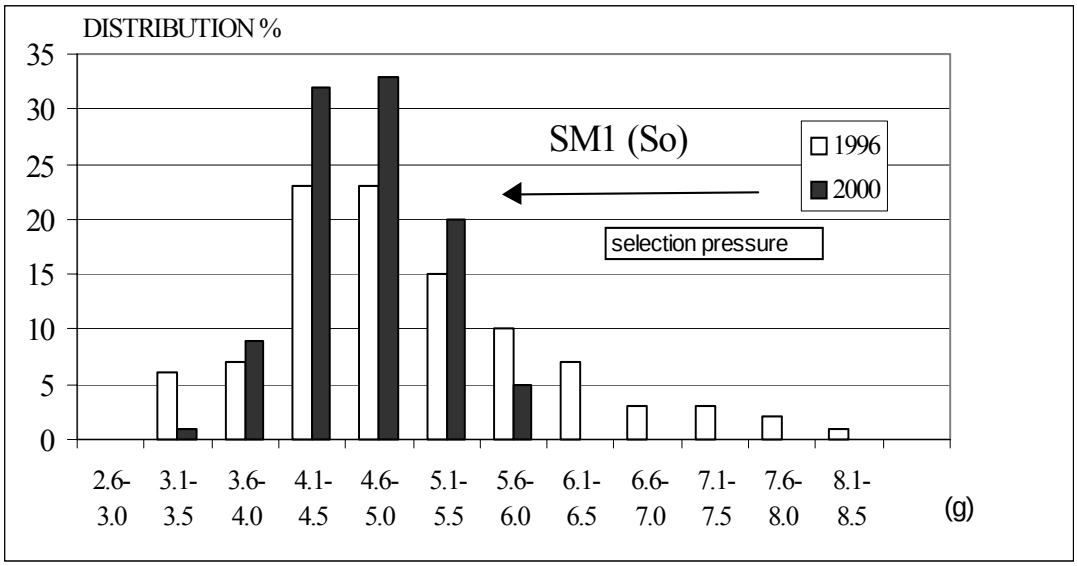

Fig. 1. Effect of individual selection on 1000 fruit mass values of *Foeniculum vulgare* lines of cv. 'Soroksári' origin (SM1).

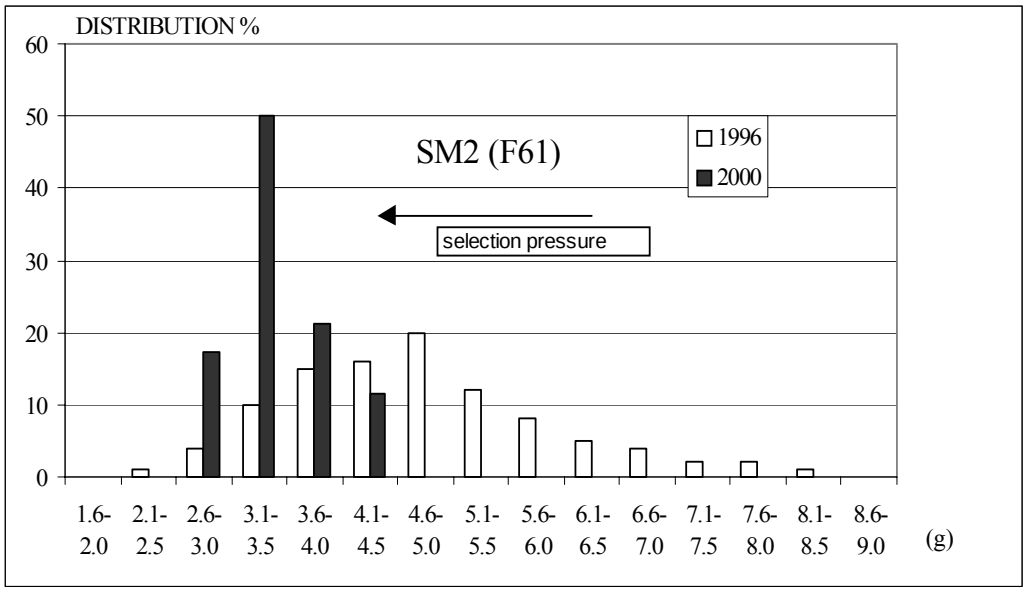

Fig. 2. Effect of individual selection on 1000 fruit mass values of *Foeniculum vulgare* lines of gene-bank 'F61' origin (SM2).

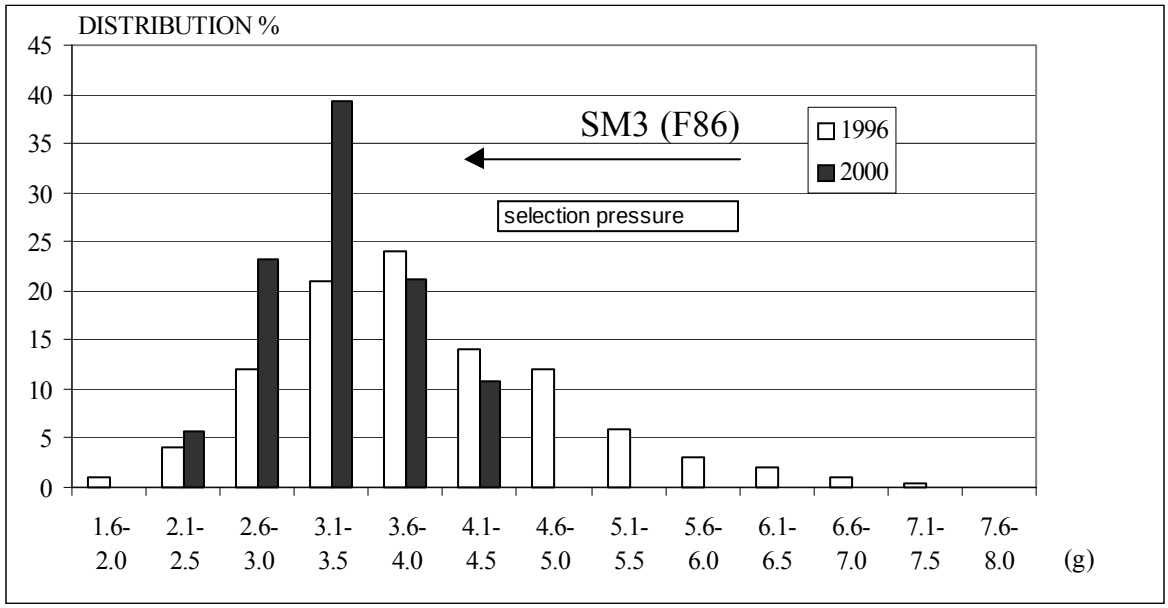

Fig. 3. Effect of individual selection on 1000 fruit mass values of *Foeniculum vulgare* lines of gene-bank 'F86' origin (SM3).

Fig. 4. Fruits of "small seeded" candidates (SM1) and standard ('Soroksári') used in comparison test.