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Experiments on the cultivation of dandelion for salad use.I

Study of cultivation methods and their influence on yield and sensory quality

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Abstract. Cultivation of mild-tasting dandelion types for salad use has been studied as one part of an investigation aimed at evaluation the possible uses of dandelion. Eleven Finnish agamospecies were compared with two middle-European varieties, 'Vollherziger, verbesserter' and 'Vert de Montmagny' in regard to preferred methods of cultivation as well as to yield level and quality properties. Further, suitability and effects of the culturing methods were studied, the main variables being level of fertilization and use of various coverings to bleach the rosettes. Of the cultivation properties, particularly the earliness, flowering, winter hardiness, vigour of growth and resistance against diseases and pests were considered.

The yields in spring varied between about 50 and 150 kg/are. When growth was in light the bitterness of all the agamospecies and varieties studied was only slight and when effective covering was used bitterness was insignificant. The sensory quality varied somewhat depending on the agamospecies or variety and method of cultivation, being at best very good and at worst satisfactory.

In the conditions studied, the higher level of fertilization was too high.

The single black film, the black fibre cloth and thick bark humus layer were all suitable coverings. Though they decreased the yield (at least when calculated as dry matter), the coverings improved the taste and texture of the rosettes. With film and fibre cloth, rosettes were somewhat more greenish and yields better than with bark humus. The humus also made the rosettes more succulent and crisp, so that the texture was improved. This method is laborious, however, and better suited for home gardening than commercial cultivation.

Of the agamospecies and varieties studied, the best for cultivation in light were *Taraxacum hemicyclum, T. tanyphyllum,* 'Vollherziger verbesserter' and 'Vert de Montmagny. For cultivation under covering the best were 'Vert de Montmagny', *T. hemicyclum* and *T. pallidipes.*

Index words: dandelion, salad greens, cultivation methods, agamospecies, fertilization, bleaching, yield, sensory quality, bitterness

Introduction

The possibility of utilizing the dandelion has been studied since 1977 by a group of researchers, originally from the Food Research Laboratory of the Technical Research Centre of Finland and the Department of Botany at the University of Turku, and later further from the Department of Horticulture at the University of Helsinki. The aim has been to investigate the various possible uses of the dandelion, which flourishes throughout Finland. At the start of the study, 157 samples of Finnish dandelions were removed to the Botanical Garden of the University of Turku. These samples were identified and found to represent 69 different agamospecies. The botanical, cytological and genetic properties of the agamospecies were studied in Turku by ROUSI and his co-workers (1984, in press), while the degree of bitterness was investigated by sensory methods at the Food Research Laboratory. The bitterness is an interesting property: if dandelion is used for taste-giving purposes e.g. in drinks, strong bitterness is an advantage, whereas if it is used as a salad ingredient, the bitterness should be minimal. The bitterness properties will be discussed in a forthcoming paper.

The possibility of cultivating the dandelion commercially has been studied since 1980. On the basis of the bitterness tests, those agamospecies most promising for cultivation as a salad green were selected for further investigation. The most important properties for such use are mild taste, and vigorous growth as a basis for sufficient yields. Winter-hardiness, resistance against diseases and pests, general sensory properties and nutritive value are important as well, but about these was little knowledge when the experiments were begun.

Elsewhere in the world, particularly in the Unites States and France, dandelion has been cultivated for salad use, and information is available on methods of cultivation (see the review by KANON 1982). The dandelion has apparently not been cultivated for food in Finland, though it was once experimentally grown for its rubber content (SUOMELA 1950). One important cultivation method for salad dandelion involves bleaching the rosettes. In this respect it was of interest to experiment with some new methods of horticulture, such as covering the plants with black polyethylene film, black fibre cloth, or layers of bark humus, instead of using the rather laborious methods suggested in the literature. The cultivation experiments were designed and carried out at the Department of Horticulture, and the Food Research Laboratory performed the sensory analyses and evaluations of bitterness. These results are reported in this paper, and the nutritive value and intrinsic quality properties such as nitrate content are reported in part II which follows (KUUSI, HÅRDH and KANON 1984 pp. 23—31).

Full details on the cultivation experiments can be found in the *pro gradu* work of KANON (1982). Experiments concerning the winter-forcing of salad dandelion will be reported at a later date.

Material and methods

Material. The material consisted of 11 Finnish agamospecies, selected from the 69 agamospecies primarily on the basis of their mild taste (= low degree of bitterness) and vigorous growth. For comparison, two foreign cultivars were included in the experiments: 'Vollherziger, verbesserter' Mauser of Swiss origin, and 'Vert de Montmagny' Vilmorin of French origin. The seeds of the Finnish agamospecies were collected in 1978 and 1979 from the experimental cultures in the Botanical Garden of the University of Turku, and stored at + 5°C. The seeds of the foreign cultivars were obtained commercially. The agamospecies and varieties are listed in the tables.

Design of the cultivation experiments: Two main experiments were performed: 1) comparison of the different agamospecies

and varieties and evaluation of bleaching with black film, and 2) comparison of two levels of fertilization and of different methods of covering. The experimental method was that of split plots with four replications.

Cultivation methods: The seedlings were grown in a glasshouse, where mean temperature was 20°C and humidity 71 % (8 o cl.). Seeds were sown in April in 5×8 cm peat pots (FP 620), filled with light, medium porosity, medium fertilized peat (St-400 B_2), two seeds per pot. The seeds were covered with a 0.5 cm layer of sand and protected against evaporation with colourless film until after germination. Later, the less advanced seedling was removed from each pot. In the first experiment comparing the agamospecies and varieties the glasshouse cultivation was continued for 6 ½ weeks, in the second, fertilization and covering experiment for nearly 6 weeks. In the second experiment the variety used throughout was 'Vert de Montmagny'. Planting outdoors took place the end of May. Planting distance was 20 cm and distance between the rows 50 cm.

Care of the cultures included mechanical weeding and weeding by hand. The flower stalks and buds were removed every week. During long periods of dry weather irrigation was applied, four times approximately 15 mm each time.

Fertilization and use of coverings. The experimental field was inclined slightly toward the northwest, the soil type was medium-humus fine sand. The area had been ploughed the previous autumn. Before basic fertilization the nutrient level was according to analysis (by Viljavuuspalvelu Oy) the following:

Conductance	pH	Exchangeable Ca mg/l	Exchangeable K mg/l	Easily soluble P mg/l	Water soluble B mg/l	Nitrate NO_3-N mg/l
1.7	7.1	1900	280	50	1	< 10

Basic fertilization was carried out before planting the seedlings outdoors. In the first experiment 10 kg/are of Fertilizer Mixture for Gardens Y I* was applied, in the second experiment either 8 or 16 kg/are of the same mixture. In the second experiment an additional 1 or 2 kg/are calcium nitrate ($Ca(NO_3)_2$, 15.5 % N) was applied in April before laying of the covering. The nutrient status of the soil was checked in the second spring before the beginning of growth and after harvesting.

The coverings used were bark humus (bark humus of Kirkniemi, lime added and basic fertilizing done), black polyethylene film (thickness 0.05 mm), and black slitted »Fibertex» cloth. The bark humus was applied 1) before planting of the seedlings outdoors, as a layer 2.5-cm thick, or 2) after the plants had withered in November, as a 5-cm thick winter covering, or 3) in addition to 2), at the end of April as a further layer of 5 cm. In this last case the covering was intended for bleaching of the rosettes. The other coverings to bleach the rosettes were similarly applied at the end of April, when the uppermost 10 cm of the surface of the earth was unfrozen and the dandelions had begun to grow. The black film was supported by arches ca. 50-cm high in the first experiment, while in the second experiment the covering had no support. The fibre cloth was similarly unsupported. The edges of both the film and fibre cloth were anchored with earth.

In one part of the covering experiment the black film was applied double; when single, the bleaching was insufficient. When the temperature rose too high the film and fibre cloth coverings were opened to allow ventilation.

Observations in the field during the

* composition, %: Main nutrients N-P-K = 10-4-17 (P^2O^5, K^2O), B 0.15, Cu 0.4, Mn 0.7, Mg 2.5, Mo 0.02, Zn 0.03, Fe 0.1

growing season. The viability of the plants was checked after transfer to the field in June and at the end of the growth season in September, the winter hardiness at harvest in the spring.

The start of flowering was noted during the first summer and the flower stalks were counted every week. In spring the rosettes were inspected for flower buds.

The earliness of withering was checked at the end of the season, and the earliness of sprouting at the end of April, where this was not prevented by the coverings. Numerical scales were used to register the differences.

The diseases and pests occurring were identified at the Departments of Plant Pathology and Agricultural and Forest Zoology of the University of Helsinki. The damage was followed and the degree assessed using a numerical scale (0—4) weekly or every other week.

In the first experiment *harvesting* took place the second spring between May 18 and 22, in the second experiment on May 19 and 20. The rosettes were cut ca 1 cm below ground level to keep the rosettes intact. Withered leaves were removed and the rosettes stored at +1—2°C, wrapped in plastic pouches.

Yields were determined by weighing the harvested and cleaned rosettes and calculated as kg/are. Weighing was carried out in spring and in August of the first year.

The sensory evaluation was done according to established principles (see e.g. AMERINE et al. 1965). Evaluation was performed on the day of harvest by 8 to 12 trained panelists. The point scale of Karlsruhe, 1—9,

SALAD DANDELION

Name _____ Date _____

Evaluate the samples using the scale of Karlsruhe, taking into account their suitability for salad use. Evaluate the colour, appearance and smell from the whole rosettes on the side table and the texture and taste from the cut leaves. Rinse your mouth carefully between the samples when evaluating the taste.

Sample	Colour	Appearance	Smell	Texture	Taste	Comments
K						
L						
M						
R						
S						
T						

The Karlsruhe point scale:

colour, appearance, texture, smell, taste 1—9

9 excellent
8 very good
7 good
6 satisfactory
5 fair
4 barely acceptable
3 defective
2 poor
1 very poor

Fig. 1. The form for the sensory evaluation of salad dandelion

EVALUATION OF THE BITTERNESS

Name _____ Date _____

The following samples should be evaluated for their bitterness in such a way that a sample that is not bitter at all receives the score 0 and extremely bitter sample the score 6. To make your evaluation easier the standard sample K which represents a medium bitterness and has a score of 3, is included.

The following scale should serve as a guide in the evaluation:

0 = not bitter at all
1 = clearly less bitter than the standard
2 = somewhat less bitter than the standard
3 = same bitterness as the standard
4 = somewhat more bitter than the standard
5 = clearly more bitter than the standard
6 = much more bitter than the standard

Sample	K	L	M	R	S	T
Degree of bitterness	3					
Comments						

Fig. 2. Form for the evaluation of bitterness

was used (see PAULUS et al. 1969) with separate points given for appearance and colour, texture, smell and taste. Appearance, colour and smell were evaluated from whole rosettes, texture and taste from leaves that had been shredded without removal of the vein and served as such. (Fig. 1 shows the evaluation form.)

Bitterness was evaluated from extracts prepared immediately after harvesting from the replicate leaf samples. Thus, 18 g leaves was homogenized in 100 ml distilled water with a Bamix for 2 min., after which the homogenate was boiled for 2 min., cooled, filtered and diluted to 100 ml with distilled water. The degree of bitterness was evaluated by 5 trained panelists using a numerical scale between 0 and 6, where bitterness value 3 (= medium) was fixed with a quinine standard of strength 0.0015 % quinine in distilled water. (Fig. 2 shows the evaluation form.)

Results

Observations in the field. The earliness of growth in the second year was evaluated at the end of April using a numerical scale 0—3. (Fig. 3). The agamospecies *Taraxacum alatum, T. ekmanii* and *T. hjeltii* were the earliest, with the foreign varieties closely behind. A similar order was observed at harvest.

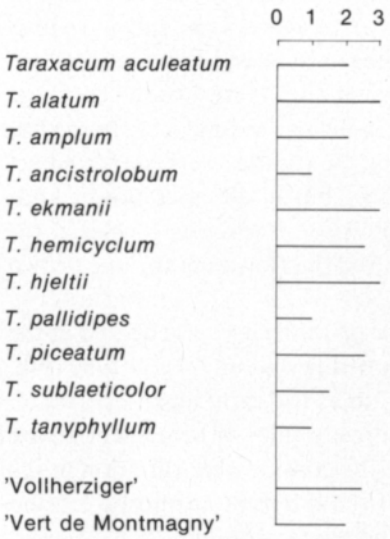

Fig. 3. Earliness of sprouting 29 Apr. 1981. Scale 0—3
0 = growth not yet begun
1 = viability of the terminal bud observed
2 = rosette consists of thickened nerves almost without lamina
3 = rosette shows large lamina

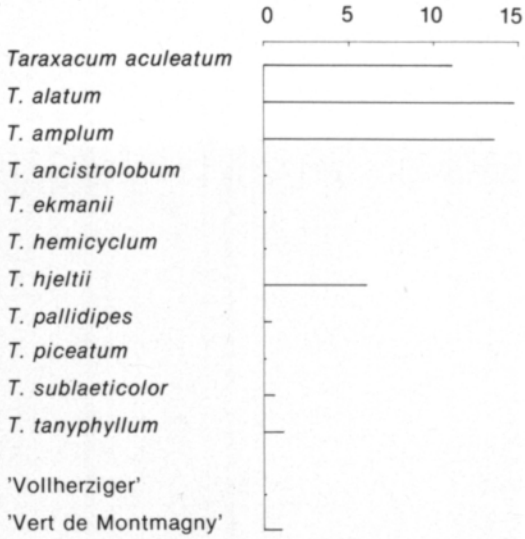

Fig. 4. Number of flowers of different agamospecies and varieties during the first year of growth

Since *flowering* lessens the nutrient reserves and removal of the flowers occasions extra work, it would be optimal if the plants did not flower in the first growing season. Further, dandelions may then be transferred to undesired places. The earliest to flower was *T. hjeltii,* followed by *T. alatum, T. amplum* and *T. aculeatum* in July—August. The others began to flower at the end of September of not at all. Figure 4 shows the trend for flowering during the first year. In the following spring the rosettes were harvested before flowering, but in all cases flower buds were present. Use of covering to bleach the rosettes delayed the flowering for one or two weeks.

The extent of withering was checked at the end of the growing season, 6 Nov. 1980 (Fig. 5). By that time, the early agamospecies *T. hjeltii* was already fully withered. The figure makes clear the considerable variation in the withering of the different agamospecies and varieties. The *winter hardiness* was checked after the winter and it was noted that, in all, 6.7 % of the plants perished during the winter. In this respect, however, there were no systematic differences between the agamospecies and varieties.

Plant diseases: The following were the most important diseases observed:

Sphaerotheca fuliginea (SCHLECHT ex Fn.) Poll. (powdery mildew)
Puccinia taraxaci (Rebent.) Plowr., 0, II/I (dandelion rust)
Ramularia taraxaci Karst., (dandelion leaf spot) and
Botrytis cinerea Pers. (grey mould).

The diseases were most conspicuous from mid-August until the end of September, but in spring they did not harm the rosettes to be harvested. Figure 6 shows the susceptibility of the different agamospecies and varieties to these diseases.

Among *pests,* the insects *Delia floralis* Wied. (turnip root fly), *Mamestra brassicae* L. (cabbage moth) and *Meligethes aeneus* F. (pollen beetle) were observed, while ticks and aphids were not. Larvae of the turnip root fly damaged the roots of *T. ekmanii* in July, but two thirds of the plants recovered by forming a new root. The larvae of cabbage moth damaged the receptacles irregularly in

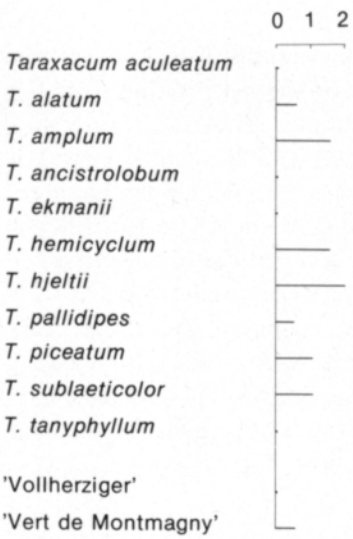

Fig. 5. Earliness of withering of different agamospecies and varieties. 6 Nov. 1980. Scale 0—2
0 = rosette unwithered
1 = rosette partly withered
2 = rosette fully withered

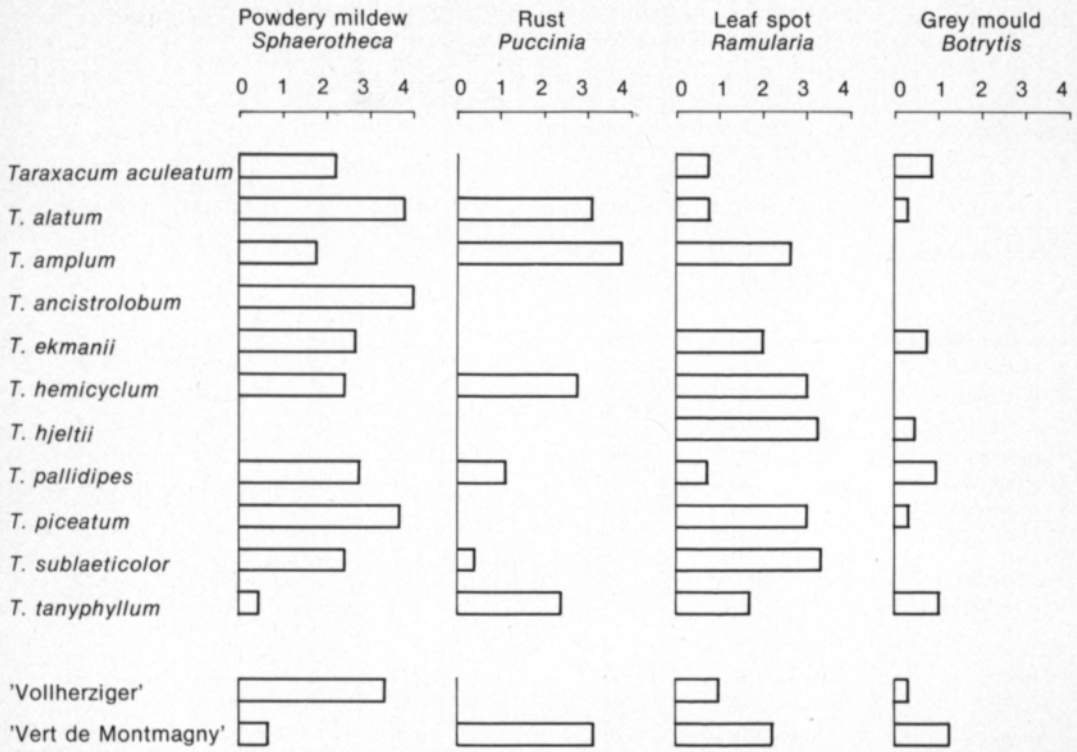

Fig. 6. Susceptibility of different agamospecies and varieties to diseases (the greatest degree of infection during the first season of growth). Scale 0—4

0 = no infection
1 = weak infection
2 = medium »
3 = strong infection
4 = very strong »

late summer. Pollen beetles appeared abundantly at the end of August but did not cause damage.

In addition, damage by voles to leaves and roots was noticed in late autumn, and 16 plants were destroyed (1.9 %).

The *yield results* are shown in Table 1. Average yields of the foreign varieties were mostly somewhat higher than those of the Finnish agamospecies, though individual yields of some of the latter were at the same level. The fresh weights were higher in late summer than in spring in many cases. However, salad dandelion is typically harvested in spring, and thus the higher yield in late summer would ordinarily not be utilized. The influence of darkness is clear-cut: yields tend to be much lower in darkness.

The higher level of fertilization did not increase the yield. Of the coverings, the bark humus systematically decreased the yield, and the black film and fibre cloth increased it.

The *results of the sensory evaluations* in Table 2 show slightly higher averages for the foreign varieties than the domestic agamospecies. For cultivations in light, the scores of taste and texture are generally lower than the scores for colour, appearance and smell. Bleaching systematically improved the scores, in particular taste and texture, and to some extent colour. Some of the Finnish agamospecies have scores as high as the foreign varieties, although the latter show a clearer superiority when bleached.

The scores for the two fertilization levels are very similar: fertilization had no influence on the sensory properties. In contrast,

Table 1. Yields of different dandelion agamospecies and varieties (fresh weight of the rosette, g, and yield calculated as kg/a), and the effect of the different methods of cultivation.

YIELDS OF DIFFERENT AGAMOSPECIES AND VARIETIES

Agamospecies or variety	Yield, weight of rosette, g			Yield, kg/a	
	Spring 1981		Summer 1980	Spring 1981	
	In light	In darkness	In light	In light	In darkness
Taraxacum aculeatum	107	83	155	107	81
T. alatum	108	72	60	106	60
T. amplum	102	97	118	96	78
T. ancistrolobum	86	61	51	81	55
T. ekmanii	85	68	93	75	54
T. hemicyclum	127	115	169	127	106
T. hjeltii	103	78	72	66	70
T. pallidipes	109	107	166	96	92
T. piceatum	90	79	116	77	79
T. sublaeticolor	69	67	124	69	61
T. tanyphyllum	123	53	272	111	43
'Vollherziger'	106	58	120	106	51
'Vert de Montmagny'	129	111	172	116	101
Averages:					
Finnish	101	80	127	92	78
Foreign	118	85	146	111	76
All	103	81	130	95	72

EFFECT OF DIFFERENT METHODS OF CULTIVATION (VARIETY 'VERT DE MONTMAGNY')

Covering	Yield, weight of rosette, g		Yield, kg/a	
	Fertilizing level		Fertilizing level	
	1×	2×	1×	2×
No covering	118	108	118	97
Bark humus 2.5 cm	81	88	62	79
Bark humus 5 cm	92	81	90	80
Bark humus 5 + 5 cm	94	75	92	70
Black film	155	144	147	86
Black film and bark humus 5 cm	119	110	116	104
Black fibre cloth	146	132	139	125
Average	115	105	109	92

covering improved the sensory properties if definite bleaching was obtained. Of the bark humus coverings only the 10 cm covering was effective in this way.

The results of the *bitterness* tests are shown in Table 3. In this respect the different agamospecies and varieties varied markedly, even though all had been selected for their mild taste. The range of values was widest in the late summer when the bitterness was also greatest. The foreign varieties tend to be more bitter than the Finnish agamospecies. However, the bitterness is low in all: on the scale used here, 3 represents medium bitterness, and in the spring dandelions all scores were below this, varying between 1.3 and 3.0 when cultured in light and between 0.8 and 2.0 when cultured in darkness. Salad dandelion is not ordinarily harvested in late summer when the bitterness is greater.

Table 2. Results of the sensory evaluation of leaves of different dandelion agamospecies and varieties, and the effect of different methods of cultivation

SENSORY PROPERTIES OF DIFFERENT AGAMOSPECIES AND VARIETIES. I: IN LIGHT

Agamospecies or variety	Colour	Appearance	Texture	Smell	Taste	Sum of points
Taraxacum aculeatum	6.6	6.7	5.7	6.7	5.3	31.0
T. alatum	7.0	7.2	6.8	7.2	5.9	34.1
T. amplum	6.7	7.1	6.3	6.7	5.8	32.6
T. ancistrolobum	6.4	6.6	5.4	6.5	5.0	29.7
T. ekmanii	6.6	6.7	6.0	7.0	5.4	31.7
T. hemicyclum	6.9	7.2	6.7	7.2	6.1	34.1
T. hjeltii	6.7	7.0	5.6	6.8	5.7	31.8
T. pallidipes	6.5	6.1	5.6	7.1	5.8	31.1
T. piceatum	6.0	6.1	5.2	6.8	4.9	29.0
T. sublaeticolor	6.8	7.4	6.0	7.3	5.1	32.6
T. tanyphyllum	6.5	6.8	5.6	7.4	5.3	31.6
'Vollherziger'	7.0	7.6	6.4	7.3	5.9	34.1
'Vert de Montmagny'	6.5	6.5	5.9	7.0	5.9	31.8
Averages:						
Finnish	6.6	6.8	5.9	7.0	5.5	31.8
Foreign	6.8	7.1	6.2	7.2	5.9	33.0
All	6.6	6.8	5.9	7.0	5.5	31.9
II: IN DARKNESS						
Taraxacum aculeatum	7.2	5.8	7.4	6.8	7.6	34.8
T. alatum	7.8	6.5	7.5	7.4	7.1	36.3
T. amplum	7.7	6.0	7.4	7.0	7.9	36.0
T. ancistrolobum	7.3	6.8	7.2	7.4	7.0	35.7
T. ekmanii	7.8	7.4	7.1	7.4	7.6	37.3
T. hemicyclum	7.6	7.2	7.3	7.3	7.0	36.4
T. hjeltii	7.8	7.6	7.6	6.3	7.3	36.5
T. pallidipes	7.8	7.5	7.4	6.8	7.1	36.5
T. piceatum	7.4	7.0	7.3	7.3	7.2	36.2
T. sublaeticolor	7.4	7.4	7.4	7.1	6.5	35.8
T. tanyphyllum	6.9	6.9	7.2	7.5	7.2	35.7
'Vollherziger'	8.3	8.0	8.0	7.6	8.0	39.9
'Vert de Montmagny'	7.6	7.6	8.1	7.7	7.8	38.8
Averages:						
Finnish	7.5	6.9	7.3	7.1	7.2	36.1
Foreign	8.0	7.8	8.1	7.7	7.9	39.4
All	7.6	7.1	7.5	7.2	7.3	36.6

EFFECT OF THE DIFFERENT METHODS OF CULTIVATION (VARIETY 'VERT DE MONTMAGNY')

Covering and fertilizing level	Colour	Appearance	Texture	Smell	Taste	Sum of points
Fertilizing level 1×						
No covering	6.2	6.5	6.4	7.1	6.1	32.3
Bark humus 2.5 cm	6.1	6.5	6.2	7.1	5.8	31.9
Bark humus 5 cm	6.0	6.4	6.4	7.2	6.0	32.0
Bark humus 5+5 cm	6.4	6.3	6.8	6.7	7.2	33.7
Black film	7.1	5.9	7.6	6.0	7.4	33.9
Black film and bark humus 5 cm	7.1	7.5	7.1	7.0	7.2	36.2
Black fibre cloth	8.1	7.5	7.9	6.6	7.5	37.5
Averages	6.7	6.7	6.9	6.8	6.7	33.9

Fertilizing level 2×						
No covering	6.1	6.5	6.5	7.0	6.2	32.4
Bark humus 2.5 cm	5.9	6.5	6.7	6.9	6.0	32.0
Bark humus 5 cm	5.8	6.0	6.6	7.0	6.5	32.0
Bark humus 5 + 5 cm	6.0	5.8	6.5	6.0	7.3	31.5
Black film	7.3	6.9	7.8	6.7	7.7	36.4
Black film and bark humus 5 cm	7.0	6.9	7.4	6.7	7.3	35.3
Black fibre cloth	8.1	7.2	7.8	5.9	7.5	36.4
Averages	6.6	6.5	7.0	6.6	6.9	33.7
Influence of fertilizing level:						
No covering						
1×	5.8	6.0	6.1	7.1	5.2	30.1
2×	6.0	6.0	6.1	7.1	4.7	29.9
Black fibre cloth						
1×	8.1	8.1	7.4	7.5	6.2	37.3
2×	8.1	7.9	7.7	7.3	6.8	37.7

Table 3. Bitterness of leaves of different dandelion agamospecies and varieties, and the effect of different methods of cultivation (scale 0—6)

BITTERNESS OF THE DIFFERENT AGAMOSPECIES AND VARIETIES

Agamospecies or variety	In light		In darkness
	Spring 1981	Summer 1980	Spring 1981
Taraxacum aculeatum	2.3	4.7	0.8
T. alatum	1.4	3.2	2.0
T. amplum	3.0	5.0	1.3
T. ancistrolobum	1.8	4.8	
T. ekmanii	1.3	3.0	
T. hemicyclum	1.9	2.6	1.3
T. hjeltii	2.4	2.8	
T. pallidipes	1.9	4.5	
T. piceatum	1.5	3.2	
T. sublaeticolor	2.6	4.9	0.9
T. tanyphyllum	1.6	2.9	0.8
'Vollherziger'	2.4	4.8	1.2
'Vert de Montmagny'	2.1	4.1	1.4
Averages:			
Finnish	2.0	3.8	1.2
Foreign	2.3	4.5	1.3
All	2.0	3.9	1.2

EFFECT OF DIFFERENT METHODS OF CULTIVATION (VARIETY 'VERT DE MONTMAGNY')

Covering	Fertilizing level	
	1×	2×
No covering	1.6	1.6
Bark humus 2.5 cm	1.5	1.8
Bark humus 5 cm	1.8	1.6
Bark humus 5 + 5 cm	1.3	0.8
Black film	0.9	0.4
Black film and bark humus 5 cm	2.8	0.3
Black fibre cloth	0.9	1.0
Averages	1.5	1.1

The level of fertilization has no clear-cut influence on the degree of bitterness, but covering clearly decreased the bitterness if bleaching was obtained. A thin layer of bark humus was not sufficient for this effect.

Discussion

Among the properties studied here, the most important for the future use of the dandelion as a salad green are yield, sensory quality and degree of bitterness. Certain properties of cultivation will have to be taken into account as well. In the following the results are evaluated from the point of view of such use.

The *yields* of the different agamospecies and varieties varied widely, with *Taraxacum hemicyclum* and 'Vert de Montmagny' grown in light performing best. The level of yield corresponded to that obtained in East Germany (see HAHN & MILDNER1962), but was lower than the yield considered good in the United States (SACKETT 1975). The weights of the rosettes were greater in late summer of the first year than at harvesttime, the following spring, but the sensory quality and nutritive value were essentially better in spring. It may be added that salad dandelion is more reasonably harvested in the spring, when other salad greens are unavailable or expensive.

Although the dandelions were harvested by cutting below the upper end of the root, all except *T. hjeltii* regenerated new rosettes about one month after the harvesting, which offers the possibility of increasing the yield. The features of regeneration have been studied further in experiments to be reported separately.

The *sensory quality* was in general either satisfactory or good, and the best agamospecies and varieties, such as *T. hemicyclum* and 'Vollherziger, verbesserter' were good even without bleaching. In the spring harvest the differences in the sensory quality were only slight.

The *bitterness* varied somewhat between the different agamospecies and varieties, being clearly less in spring than in late summer, in agreement with the results of HUTTUNEN (1981). There was no correlation between the degree of bitterness and the intensity of the green colour of the leaves, typical for agamospecies, nor between bitterness and the presence or absence of red colour of the middle vein or the type of lobes in the leaves (see also HUTTUNEN 1981). Such characteristics can therefore offer no guidance when wild dandelions are being collected. In the dandelions studied here the bitterness was consistently slight, as intended.

Of the *cultivation properties,* earliness would be an advantage. In the spring of the second year, growth was sufficient from the middle of May (though that year the spring season was two weeks later than usual). The earliest agamospecies was *T. hjeltii,* which comes from northern Finland. The difference in time of harvesting was at most one week, the latest species being *T. ancistrolobum, T. tanyphyllum* and *T. pallidipes.* Hot weather may well diminish the differences in earliness, and thus this property may not be very important.

The *period of proper harvesting* is comparatively short, since immediately the rosette of leaves has reached the desired size, the flower stalks begin to lengthen and bitterness rapidly increases. This period could be somewhat prolonged by growing several agamospecies or varieties differing in earliness.

The differences in *flowering* were conspicuous: during the first growing season only a good third of the samples flowered. Where the flowers are not needed, it would be best to select species that do not flower during the first summer.

No definite differences were noticed in *winter hardiness:* all species studied were sufficiently resistant. The winter of the experiment, it may be added, was less favourable than average.

Pests, except perhaps voles, are not a threat to dandelion cultivation. Three main fungus *diseases* were observed, of which par-

ticularly powdery mildew could become harmful. Rust and leaf spot were also of importance, although they occurred mostly in late autumn. Grey mould was insignificant. The diseases do not influence the quality of the rosettes to be harvested in spring, but as general factors weakening the plants they may decrease the yield.

Of the *cultivation methods,* a higher level of *fertilization* did not increase the yield in the conditions studied. Only when bark humus was applied during the growing season, causing a need for more fertilizer, did the higher level of fertilization give better yield than the lower. The results do not exclude the possibility that the optimal level may be higher or lower than the lower level used here.

Bleaching by covering with black film significantly decreased the yield in the first experiment. In the second experiment, where the different coverings were compared, the yields for plants under film and fibre cloth were greater than for uncovered plants, while covering with bark humus diminished the yield. The results may be connected with the temperature effects of the different coverings. However, when the yield was calculated as dry matter, the yield was always lower when coverings were used, in agreement with earlier results (WASSINK 1965).

Use of coverings delayed the beginning of flowering, but the harvest period was not thereby longer, since under film and fibre cloth the rosettes may become too long, and when bark humus covering is used, harvesting must be done before the leaves penetrate the layer.

Bleaching virtually eliminated all bitterness and thereby improved the sensory quality, particularly taste. But also texture was improved: the bleached rosettes were succulent and crisp, and particularly when bark humus covering was used, the base of the petiole was pleasingly fleshy. Certainly the 10-cm layer of bark humus was not sufficient; it would be better to apply at least a 20-cm thickness, given the length of the leaves and the fact that in darkness the rosettes assume a more vertical position than when growing in light.

Comparison of the different methods of covering showed that the double black film was too tight, causing damage to the rosettes. If it was applied single, the bleaching effectiviness was somewhat less than that of the fibre cloth. Where bark humus was used growth was a little delayed, because the covering had to be laid in spring on the cold, still frozen earth, which then warmed up more slowly. Further, the bark humus covering caused a decrease in yield.

The decision to cover, as well as the type of covering, depends on the kind of crop desired. Unbleached the yield is greater, rosettes are pale green, and there is slightly more bitterness. Fibre cloth gives a crop of somewhat better quality, but it is more expensive than black film. A thick layer of bark humus gives the best texture of the rosettes, but application is laborious and the method is thus more suitable for home gardening than commercial cultivation. In addition, with bark humus covering the fertilizer level must be increased.

In comparing the merits of the *different agamospecies and varieties,* each of the properties studied must be taken into account and its importance weighed. If yield, sensory properties and mild taste, as well as resistance against diseases and pests are considered to be most important, and only half as much weight is placed on earliness, flowering properties, ability of regeneration and amounts of vitamin C and soluble solids, then the most suitable lines for culture without bleaching are *T. hemicyclum* and *T. tanyphyllum,* and the two foreign cultivars 'Vollherziger verbesserter' and 'Vert de Montmagny'. With bleaching the most suitable are 'Vert de Montmagny', *T. hemicyclum* and *T. pallidipes.* Of the Finnish agamospecies the most suitable is thus *T. hemicyclum,* where the growth of rosettes is vigorous, the yield high and taste mild, and where the sensory properties are as good

unbleached as bleached, and the yield is not significantly lowered by bleaching. This agamospecies is early in growth and does not form flowers at all during the first summer. As disadvantages, a medium susceptibility to both *Sphaerotheca* (powdery mildew) and *Puccinia* (rust) as well as also *Ramularia* (leaf spot) must be mentioned.

In all, the experiments showed that dandelion is well suited for outdoor cultivation in Finland. The harvest is exceptionally early, yield is abundant, bitterness is only slight and sensory properties are good. Results are influenced by the cultivation methods; in particular the use of coverings gives a crisper texture. The possibilities of perennial culture and breeding and the problems of seed production are topics remaining to be investigated.

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References

AMERINE, M.A., PANGBORN, R.M. & ROESSLER, E.B. 1965. Principles of sensory evaluation of food. 602 pp. Academic Press, New York and London.

HAHN, P. & MILDNER, E. 1962. Neue Gemüse- und Arzneipflanzensorten, die 1962 in die Sortenliste der DDR aufgenommen wurden. Löwenzahn. Deut. Gartenb. 9: 213—214.

HUTTUNEN, H. 1981. Viljelykokeessa olevien 71 Taraxacum-pikkulajin fenologisista, morfologisista ja kemiallisista ominaisuuksista sekä lisääntymistavasta. Pro gradu -tutkielma. Turun yliopiston biologian laitos. 69 pp.

KANON, H. 1982. Salaattivoikukka. Pro gradu -tutkielma. Helsingin yliopiston puutarhatieteen laitos. 128 pp.

KUUSI, T., HÄRDH, K. & KANON, H. 1984. Experiments on the cultivation of dandelion for salad use. II. The nutritive value and intrinsic quality of dandelion leaves. J. Agric. Sci Finl. 56: 23—31.

PAULUS, K., GUTSCHMIDT, J. & FRICKER, A. 1969. Karlsruher Bewertungsscheme — Entwicklung, Anwendbarkeit, Modifikationen. Lebensmittel-Wissenschaft u. Technol. 2 (6): 132—139.

ROUSI, A., HUTTUNEN, H. & HYRKÄS-LYYTIKÄINEN, K. 1984. Chromosomes and reproductive behaviour of Finnish Taraxacum agamospecies. Nordic Journal of Botany (in press).

SACKETT, C. 1975. Dandelions. Fruit & vegetable facts & pointers. Mimeogr. 7 pp. (Available United Fresh Fruit and Vegetable Association, Washington, USA).

WASSINK, E.C. 1965. Some introductory notes on *Taraxacum officinale* L. as an experimental plant for morphogenetic and production research. Meded. Landb. hogesch. Wageningen, Nederl. 65, 16. 15 pp.

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SELOSTUS

Tutkimuksia salaattivoikukan viljelystä. I

Viljelymenetelmät ja niiden vaikutus satoon ja aistinvaraiseen laatuun

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Voikukan hyötykäyttöä selvittävän tutkimuskokonaisuuden osana on tutkittu miedonmakuisten voikukkakantojen viljelyä salaattitarkoituksiin. Tutkimuksessa verrattiin keskenään 11 kotimaista pikkulajia ja kahta keski-eurooppalaista kantaa, 'Vollherziger, verbesserter' ja 'Vert de Montmagny', sekä viljelyominaisuuksien että satomäärän ja laadun kannalta. Edelleen selvitettiin viljelymenetelmien soveltuvuutta sekä vaikutuksia, muuttujina lannoitustaso sekä erilaisten katteiden käyttö ruusukkeiden vaalentamiseksi. Viljelyominaisuuksista kiinnitettiin huomiota erityisesti aikaisuuteen, kukintaan, talvenkestävyyteen ja elinkelpoisuuteen sekä tautien ja tuholaisten kestävyyteen.

Tulokset osoittivat, että kevätsadon määrä vaihteli rajoissa 50—150 kg/a. Kaikilla tutkituilla kannoilla kitkeryys oli vähäinen myös ilman vaalentamista, ja vaalentamalla se jäi merkityksettömäksi. Aistinvarainen laatu vaihteli tyydyttävästä erittäin hyvään riippuen kannasta ja viljelymenetelmästä.

Vallinneessa ravinnetilanteessa todettiin korkeampi lannoitustaso liian korkeaksi.

Kokeilluista vaalennuskatteista todettiin soveltuviksi yksinkertainen musta muovikalvo, musta kuitukangas ja paksu kuorihumuskate. Katteiden todettiin kylläkin vähentävän satoa (kuiva-aineeksi laskettuna), mutta parantavan makua ja rakennetta. Muovia tai kuitukangasta käytettäessä saadaan hiukan vihertävämpiä ruusukkeita ja enemmän satoa kuin kuorihumuskatteella. Viimemainittua käytettäessä ovat ruusukkeet mehevämpiä ja rapeampia. Menetelmä soveltuu kuitenkin työläytensä vuoksi paremmin kotipuutarhoihin kuin kaupalliseen viljelyyn.

Tutkituista kannoista soveltuvat vaalentamatta viljeltäviksi parhaiten *T. hemicyclum, T. tanyphyllum,* 'Vollherziger, verbesserter' ja 'Vert de Montmagny', vaalentamalla viljeltäviksi taas 'Vert de Montmagny', *T. hemicyclum* ja *T. pallidipes.*