Project title:	**Properties of peat sources used in mushroom casing**
Report:	**Final Report (1997)**
Project number:	**M 20b**
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Location:	**HRI Wellesbourne**
Project co-ordinator:	**T Haynes**
Date commenced:	**March 1996**
Date completed:	**October 1996**

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SUMMARY

Twenty-three peat samples used in the UK mushroom industry, from a range of European sources were analysed for a series of physical and chemical properties. The physical properties were initial moisture content, water retention, air-filled porosity (AFP), wet and dry bulk densities and water released under applied tensions. The chemical properties were pH, conductivity and ash content.

There were wide variations between peat sources in all of the physical and chemical analyses conducted. The initial moisture content of the samples was closely correlated with their initial wet bulk density. There was only an approximate relationship between two methods of determining the AFP; one method produced higher values than the other. On average, black peats had a higher initial moisture content, wet bulk density and ash content than brown peats. However, brown peats released more water under tension and had a higher AFP than black peats. On average, wet bulk peats had a higher initial moisture content, wet bulk density and water retention than milled peats. The volume of water released under applied tensions was greater from milled peats than from wet bulk peats.

INTRODUCTION

An HDC funded survey of UK mushroom casing materials (Project M20) showed that a wide range of peats were used. The materials range from sphagnum peat, through intermediates, to sedge peats. The level of decomposition ranges from black, deep-dug peats to younger surface peats. Two methods of peat extraction, milling and bulk extraction, are also used.

Analyses in Project M20a showed significant differences in physical and chemical properties of the peat sources. Before further experiments to determine the performance of peat sources in mushroom casing are carried out, the properties of peat sources currently used were assessed.

The work will enable growers to relate their type of peat to those used in HDC funded experiments, since it will only be possible to include a limited range of peat sources in the experiments.

Scientific/Technical Target of the Work

To determine specified physical and chemical properties of a range of peat sources currently used in the UK mushroom industry.

MATERIALS AND METHODS

Properties of peat sources

Before the determinations of air-filled porosity (AFP), moisture content, water retention and compacted bulk density were conducted, lumps larger than 20 mm were removed from the samples. Tests were conducted at 20°C on three replicate samples of each peat source.

Air-filled porosity, water retention and moisture content

The method described in BS4156 (Anon 1990) was used to measure AFP. Samples were filled into a 1 litre test cylinder fitted with a 50 mm high extension collar and closeable drainage holes in the base. After gradual wetting from the base upwards and 12h soaking, the sample was taken through three wetting (5 min) and draining (5 min) cycles. The extension collar was then removed and excess sample struck off flush with the top of the cylinder. After a further 1h soaking, the drainage holes were closed and moisture on the outside of the container was removed. The holes were then opened and the drainage water collected for 30 min and measured. The AFP based on the volume of drainage water, V (in ml) was calculated from:

$$\text{AFP, \%} = \frac{V}{10}$$

Water retention at saturation was determined by drying a sample from the test cylinder after the determination of AFP. Moisture content of the initial (unwetted) and saturated samples was determined by weighing and drying the samples at 105°C to constant weight.

A second estimate of AFP was calculated from the final wet (W) and dry (D) weights (in g) of the sample in the test cylinder using the equation developed by Waller and Harrison (1991):

$$\text{AFP(2), \%} = 96.72 - \frac{(100W - 61.9D)}{1000}$$

Water release characteristics

Water released at decreasing matric potentials was determined using a modified tension table constructed from Buchner funnels with filter paper disks (Whatman No. 1). Pores in the filter paper retained water against hanging water column potentials of less than 1500 mm water. Water-filled flexible rubber tubing forming a 'U' reservoir was attached to the funnel. A 1 mm diameter horizontal drain spout was positioned 10 mm from the free end of the tube. By lowering the free end of the tube and the height of the water level at the drain spout, water potentials from 0 to - 1500 mm water could be created in the disk and sample in the funnel in contact with the disk. The volume of water flowing from the drain spout following each lowering of the tube was measured to determine the water released from the sample at each potential. The funnels were filled with 130 g sample. Before each determination, the level of the water reservoir was first adjusted to the top of the sample for 12 h and then to the top of the disk for 12h. The materials at this point were at saturation. The matric potential was decreased in 50 mm water potential increments; equilibrium at each increment was obtained in 40-60 min. A water release curve for each peat sample was obtained by plotting the volume of water released at each potential.

Compacted bulk density

The 1 litre test cylinder and extension collar used for AFP determination were filled with the sample as described in BS 4156 (Anon 1990). A 650 g cylindrical plunger was placed on the sample for 3 min, after which the sample was struck off flush with the top of the test cylinder. The compacted bulk density was determined from the weight of the sample divided by the volume of the test cylinder. The compacted bulk densities of both fresh and air-dried samples were determined.

Conductivity and pH

Suspensions of sample in distilled water (1:6 ratio w/w) were used for determining conductivity and pH.

Ash content and decomposition of peat

Dried peat samples (0.3 g) from the determination of moisture content were heated to 480°C for 16 h in an electric furnace, followed by re-weighing of non-combusted material. Peat samples were assessed for decomposition on the 1-10 von Post scale (Pustjärvi, 1970). The compacted bulk density of air-dried peat samples was also used as a measure of decomposition (Pustjärvi, 1970).

RESULTS

Physical and chemical analyses of the different peat sources are shown in Tables 2 to 4. Water release curves of the peat sources are shown in the Appendix. For most of the peat samples, the results for the three replicate samples were fairly similar. However, results for Samples 8 Euroveen black, 20 Nooyen black and 22 Prunty were variable due to the heterogeneity of the samples used. There was a close correlation between the initial moisture content of the samples and their initial wet bulk density (Fig. 1). There was also a close correlation between the volumes of water extracted at tensions of 500 and 900 mm water (Fig. 2). There was only an approximate relationship between the two methods of determining the AFP; method (2) values were greater than method (1) values (Fig. 3).

Effects of peat types on analysis results

Table 5 shows the average analyses for different peat types. The types are grouped according to extraction method (milled or wet bulk) and decomposition (black, brown and intermediate). The decomposition is based on dry bulk density (brown peats are less than 150 g/litre; intermediate peats 150-220 g/litre and black peats more than 220 g/litre). Moisture content, wet bulk density and ash content all increased with greater decomposition (blackness) whereas the water retention, volume of water released under applied tensions and AFP (2) decreased with peat decomposition. On average, wet bulk peats had a higher initial moisture content, wet bulk density and water retention than milled peats. The volume of water released under applied tensions was greater from milled peats than from wet bulk peats.

CONCLUSIONS

1. There were wide variations between peat sources in all of the physical and chemical analyses conducted.

2. The initial moisture content of the samples was closely correlated with their initial wet bulk density. Measurement of both factors is therefore unnecessary.

3. The water released by samples at 500 mm tension was closely correlated with the water released at 900 mm tension. Measurement at a single tension is therefore adequate in order to characterise the water release.

4. There was only an approximate relationship between two methods of determining air-filled porosity. One method produced higher values than the other. Method (2), based on the final wet and dry weights of the material in the test cylinder, is probably more reliable than Method (1), based on the volume of drainage water.

5. On average, black peats had a higher initial moisture content, wet bulk density and ash content than brown peats. However, brown peats released more water under tension than black peats.

6. On average, wet bulk peats had a higher initial moisture content, initial wet bulk density and water retention at saturation than milled peats. The volume of water released under applied tension was greater from milled peats than from wet bulk peats.

REFERENCES

Anon (1990). Recommendations for peat for horticultural and landscape use, BS4156, British Standards Institution, London, 13 pp.

Pustjärvi, V. (1970). Degree of decomposition. *Peat and Plant News* **4**, 48-52.

Waller, P.I. & Harrison, A.M. (1991). Estimation of pore space and the calculation of air volume in horticultural substrates. *Acta Horticulturae* **294**, 29-39.

Table 1. Peat sources

Sample	Brand	Grade	Bulk or Milled	Country of Origin
1.	Bord na Mona (Shamrock)	Brown	M	Ireland
2.	Bord na Mona (Shamrock)	Black	M	Ireland
3.	Bord na Mona (Shamrock)	Black, Wet	B	Ireland
4.	Bord na Mona (Shamrock)	Black, Dried	B	Ireland
5.	D L Coutts (Novobalt)	Sphagnum, Fine	M	Lithuania
6.	D L Coutts (Novobalt)	Medium	M	Lithuania
7.	Euroveen	White	M	Germany
8.	Euroveen	Black	B	Germany
9.	Finnfibre (Vapo)	Black	M	Finland
10.	Finnfibre (Vapo)	Baltic brown	M	Lithuania
11.	Harte	Brown	B	Ireland
12.	Harte	Black	B	Ireland
13.	Harte	Black	M	Ireland
14.	L & P	Sphagnum	M	GB
15.	L & P	Economy	B	GB
16.	L & P	Milled	M	GB
17.	L & P	Wet	B	GB
18.	Levington	Surface Sphagnum	M	GB
19.	Levington	Brown wet	B	GB
20.	Nooyen	Black	B	Germany
21.	Nooyen	White	M	Germany
22.	Prunty		B	Ireland (N)
23.	Wilmslow		B	GB

Table 2. Moisture content (as received) and water retention and release characteristics of peat sources. Each value is the mean of 3 replicates.

Peat Source	Moisture content % w/w	Water retention† % w/w	Water released, ml per 100 ml sat. sample** at 500 mm	at 900 mm
1. Shamrock Brown - M*	62.1	86.0	35.9	38.9
2. Shamrock Black - M	79.9	88.0	37.5	44.3
3. Shamrock Black - B	86.2	89.6	25.5	31.4
4. Shamrock Dried - B	76.8	86.6	31.5	36.6
5. Novobalt Sphag - M	61.6	87.4	46.8	53.8
6. Novobalt Med - M	47.9	86.9	44.2	49.9
7. Euroveen White - M	65.8	84.7	48.7	56.4
8. Euroveen Black - B	84.2	87.2	38.5	42.5
9. Vapo Black - M	56.1	84.8	43.9	57.7
10. Vapo Brown - M	58.1	87.4	39.5	52.4
11. Harte Brown - B	89.0	92.9	37.0	41.0
12. Harte Black - B	88.7	92.0	26.0	30.5
13. Harte Black - M	80.2	88.3	26.4	30.0
14. L&P Sphag - M	54.7	83.0	43.9	48.4
15. L&P Econ - B	77.5	84.5	35.5	40.2
16. L&P - M	64.8	81.6	37.4	46.9
17. L&P Wet - B	88.6	91.3	37.0	46.9
18. Leving Sphag - M	63.8	81.9	42.9	47.8
19. Leving Wet - B	75.0	80.0	30.0	35.1
20. Nooyen Black - B	83.2	87.7	24.0	28.5
21. Nooyen White - M	61.5	87.2	50.0	58.0
22. Prunty - B	89.4	92.7	38.1	41.7
23. Wilmslow - B	85.1	88.9	23.1	27.3
LSD 0.05	1.8	1.2	1.5	1.6

† at saturation
* M = Milled; B = Bulk Extracted
** at 500 mm and 900 mm water tension

Table 3. Bulk density and air-filled porosity (AFP) of peat sources. Each value is the mean of 3 replicates

Peat Source	Dry bulk density, g/litre	Wet bulk† density, g/litre	AFP** Method 1 %	AFP** Method 2 %
1. Shamrock Brown - M*	149	267	18.0	25.9
2. Shamrock Black - M	182	477	5.6	10.2
3. Shamrock Black - B	229	615	9.3	9.7
4. Shamrock Dried - B	200	484	12.1	16.8
5. Novobalt Sphag - M	142	221	8.0	23.2
6. Novobalt Med - M	117	144	22.6	50.4
7. Euroveen White - M	217	327	6.8	12.4
8. Euroveen Black - B	206	666	11.8	14.9
9. Vapo Black - M	135	233	7.5	19.5
10. Vapo Brown - M	125	224	6.5	17.7
11. Harte Brown - B	146	550	16.5	26.0
12. Harte Black - B	261	680	17.1	26.9
13. Harte Black - M	226	393	19.5	27.8
14. L&P Sphag - M	189	256	9.8	26.5
15. L&P Econ - B	215	517	10.3	13.1
16. L&P - M	253	386	6.6	15.5
17. L&P Wet - B	241	714	26.0	27.6
18. Leving Sphag - M	225	334	7.4	19.8
19. Leving Wet - B	267	544	7.7	13.4
20. Nooyen Black - B	231	615	9.6	13.3
21. Nooyen White - M	142	227	4.5	14.8
22. Prunty - B	161	549	17.4	22.7
23. Wilmslow - B	265	573	11.7	15.4
LSD 0.05	4	6	1.3	1.7

* M = Milled; B = Bulk Extracted

** Method 1 is based on the volume of drainage water and Method 2 is based on the final wet and dry weights of the material in the test cylinder

† peat sample as received

Table 4 Chemical properties of peat sources. Each value is the mean of 3 replicates.

Peat Source	**pH**	**Conductivity µS**	**Ash % of d.mt**
1. Shamrock Brown - M*	3.6	94	2.2
2. Shamrock Black - M	3.6	113	2.2
3. Shamrock Black - B	4.8	93	5.4
4. Shamrock Dried - B	3.5	151	1.4
5. Novobalt Sphag - M	3.8	71	1.9
6. Novobalt Med - M	3.1	387	1.3
7. Euroveen White - M	4.3	121	4.9
8. Euroveen Black - B	4.5	105	1.9
9. Vapo Black - M	4.2	62	3.6
10. Vapo Brown - M	3.8	99	2.1
11. Harte Brown - B	5.5	111	7.5
12. Harte Black - B	4.7	116	3.9
13. Harte Black - M	5.2	47	5.4
14. L&P Sphag - M	4.2	125	4.5
15. L&P Econ - B	4.3	85	4.2
16. L&P - M	4.3	102	7.2
17. L&P Wet - B	4.4	88	3.5
18. Leving Sphag - M	3.6	189	2.5
19. Leving Wet - B	4.1	111	10.5
20. Nooyen Black - B	4.2	110	2.0
21. Nooyen White - M	4.0	92	2.6
22. Prunty - B	4.7	59	1.5
23. Wilmslow - B	4.3	101	2.1
LSD 0.05	0.2	3	0.3

*M = Milled; B = Bulk Extracted

Table 5 Effect of peat decomposition and extraction method on physical and chemical properties

Peat type	Moisture † content, % w/w	Water* retention, % w/w	Water released, ml per 100 ml sat. sample		Dry bulk density, g/litre	Wet bulk† density, g/litre	AFP** Method 1 %	AFP** Method 2 %	pH	Conductivity µS	Ash % of d.m.
			at 500 mm	at 900mm							
Black	79.4	86.6	30.7	36.8	247	558	11.9	16.0	4.3	114	4.6
Intermediate	73.8	86.9	38.2	44.2	169	433	11.2	18.1	4.3	96	3.3
Brown	63.4	87.5	42.2	49.0	137	272	12.7	25.4	4.0	142	2.9
Milled	63.0	85.6	41.4	48.7	157	239	10.2	22.0	4.0	125	3.4
Wet bulk	84.0	88.5	31.5	36.5	220	592	13.6	16.9	4.5	103	4.0
Mean	73.5	87.0	36.5	42.6	189	416	11.9	19.5	4.2	114	3.7

† peat sample as received
* at saturation
** Method 1 is based on the volume of drainage water, Method 2 is based on the final wet and dry weights of the material in the text cylinder

Fig.1 Relationship between wet bulk density and moisture content of peat samples

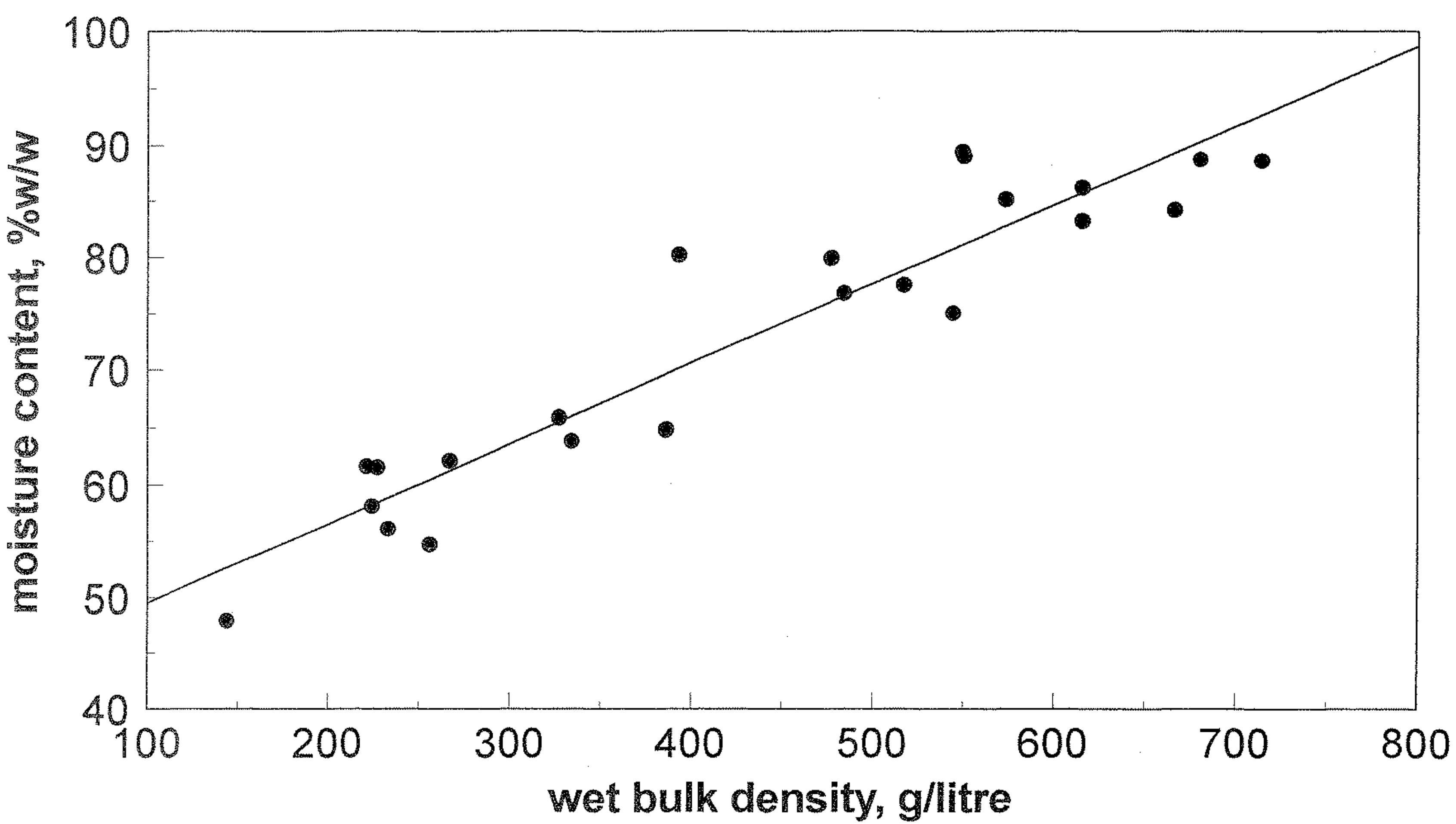


Fig.2 Relationship between water volumes extracted at tensions of 500 and 900mm water

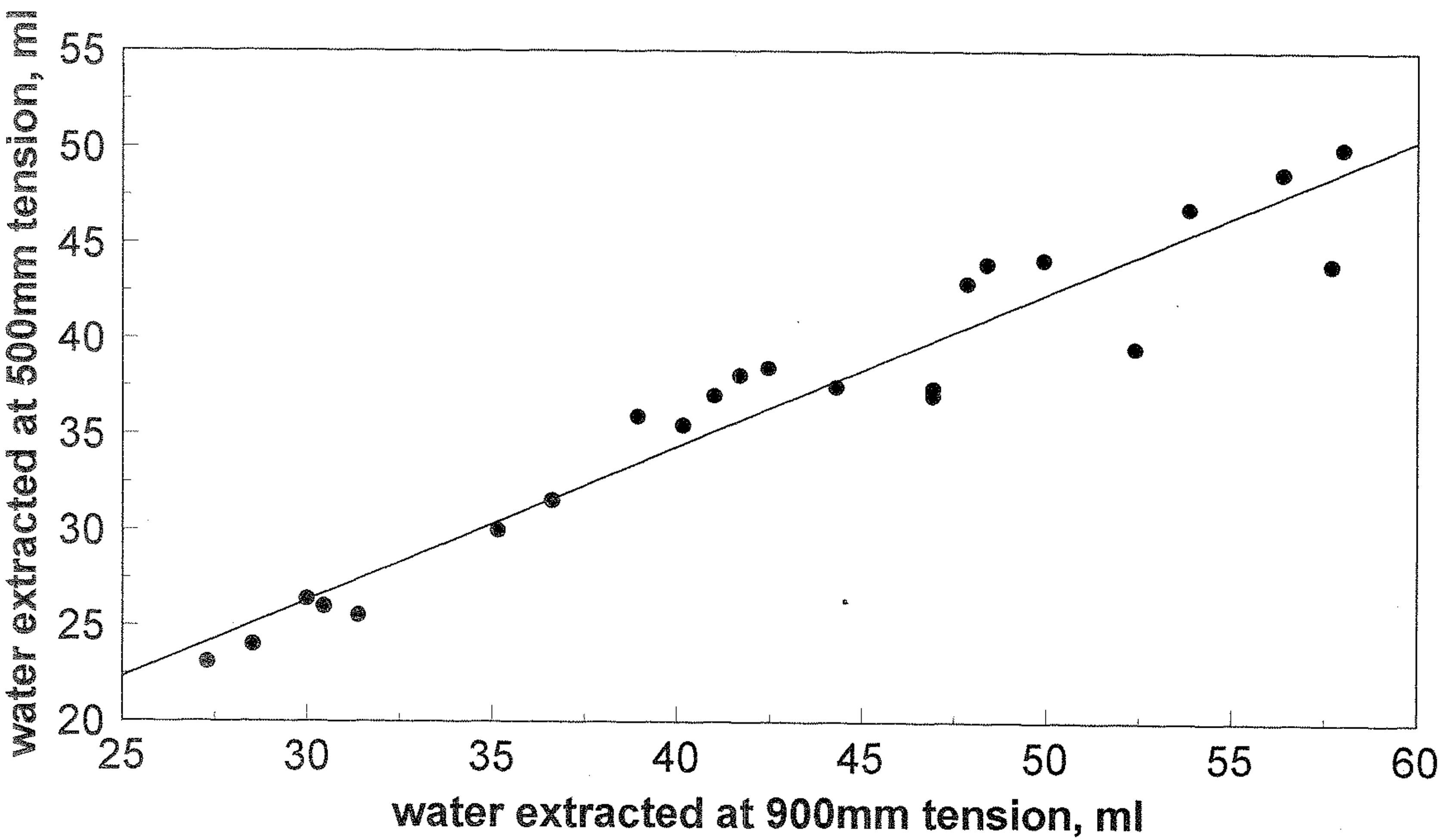
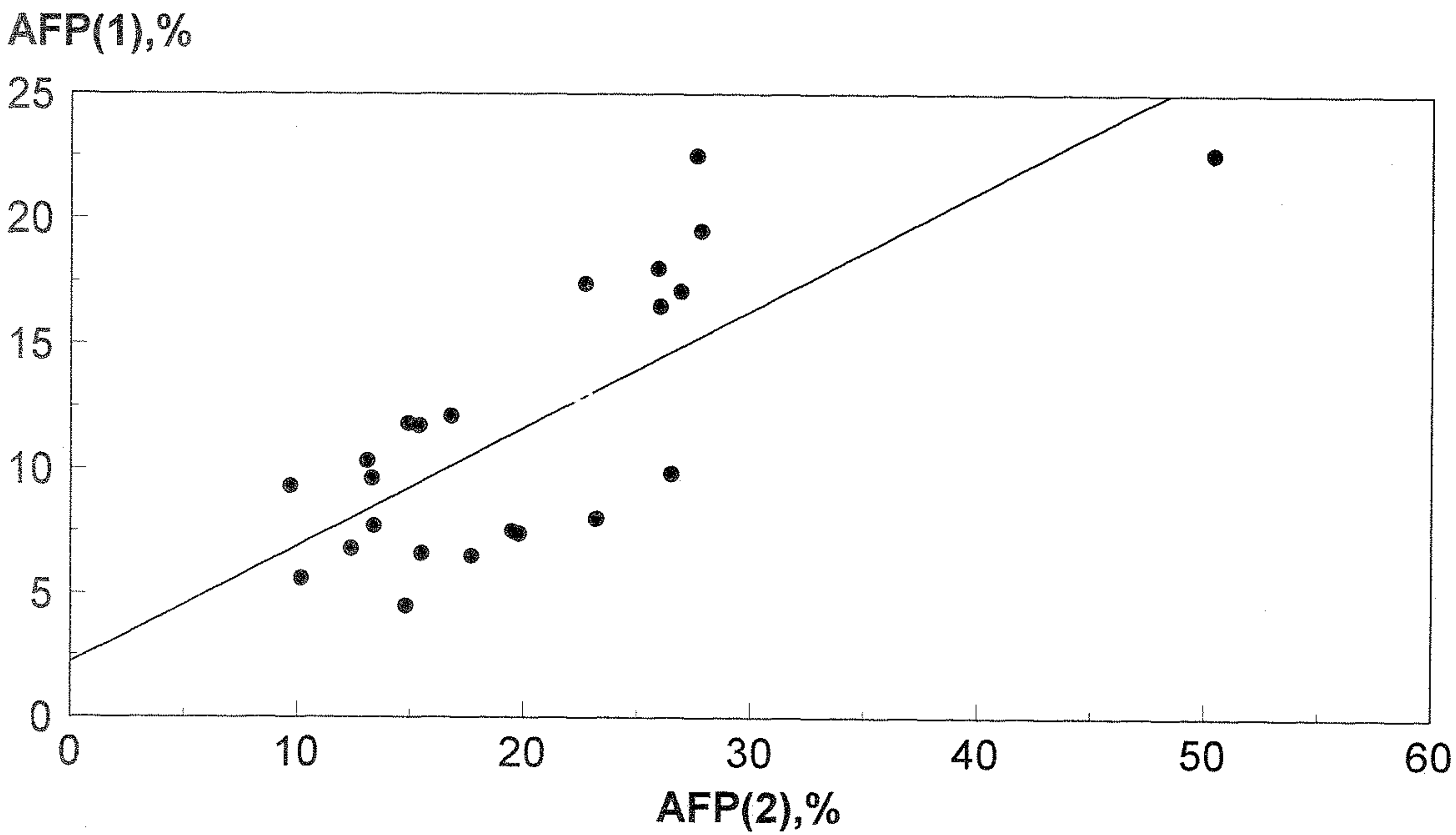


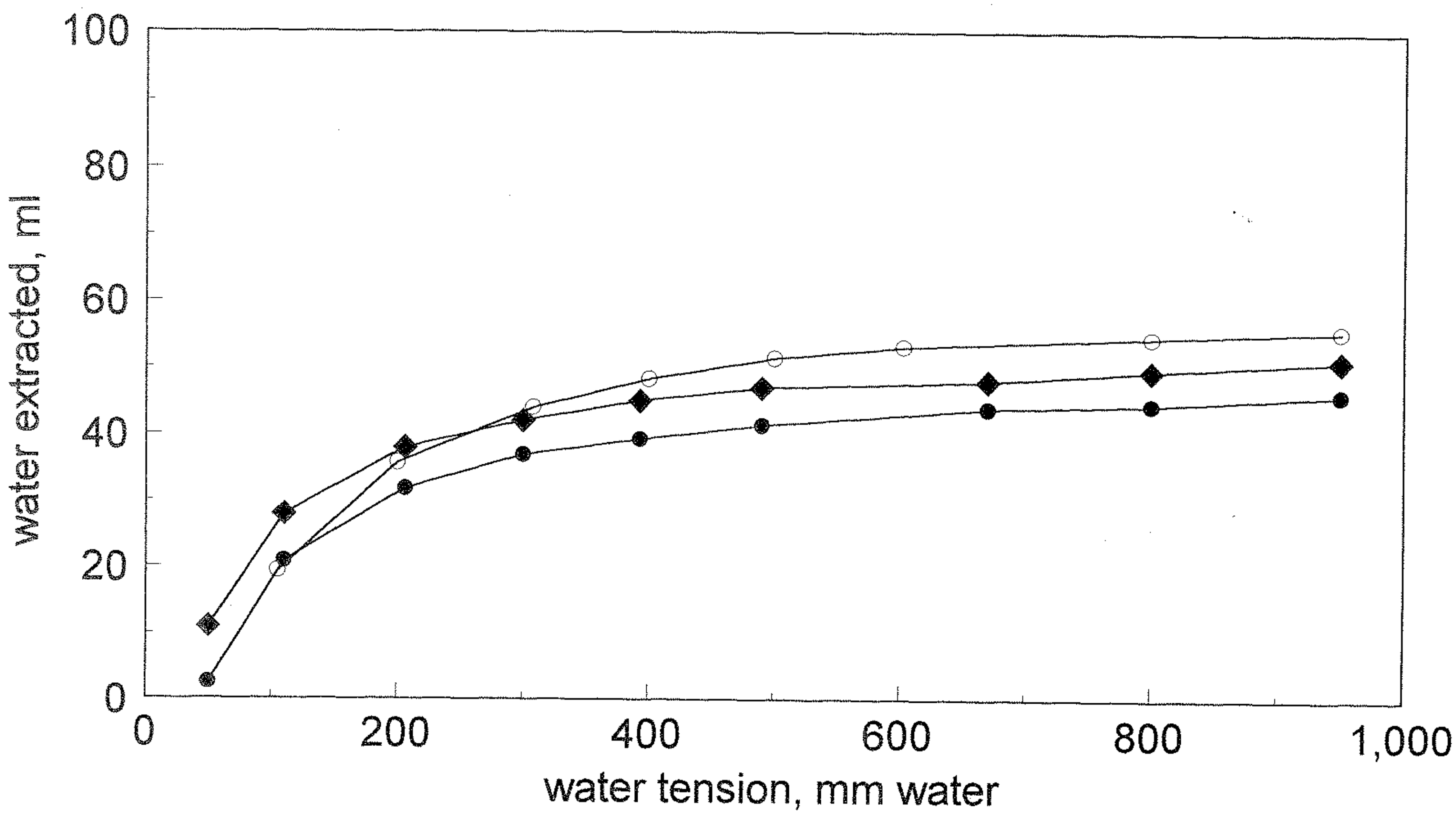
Fig. 3 Relationship between air-filled porosity determinations from methods (1) and (2)



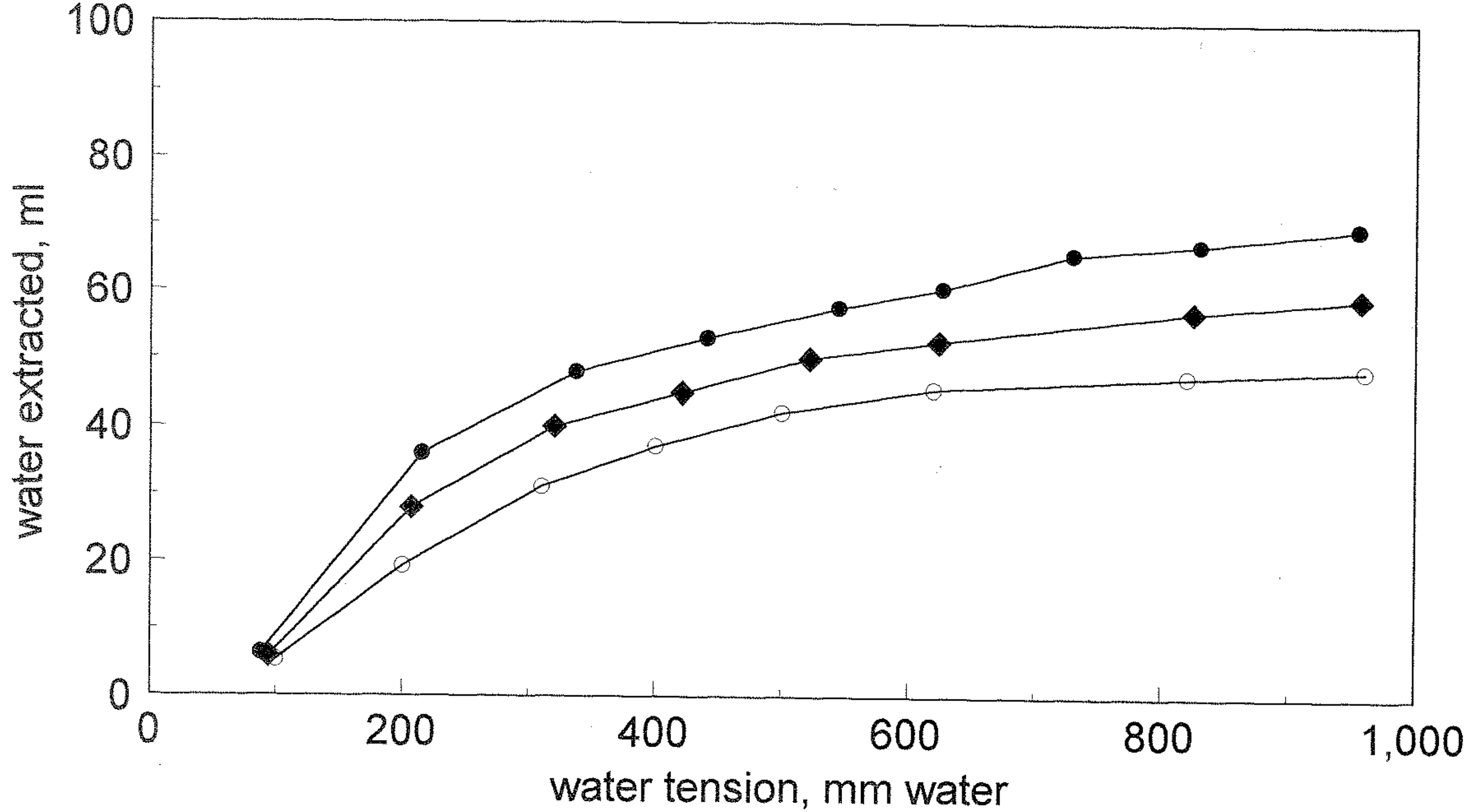
APPENDIX

Water release curves of peat samples

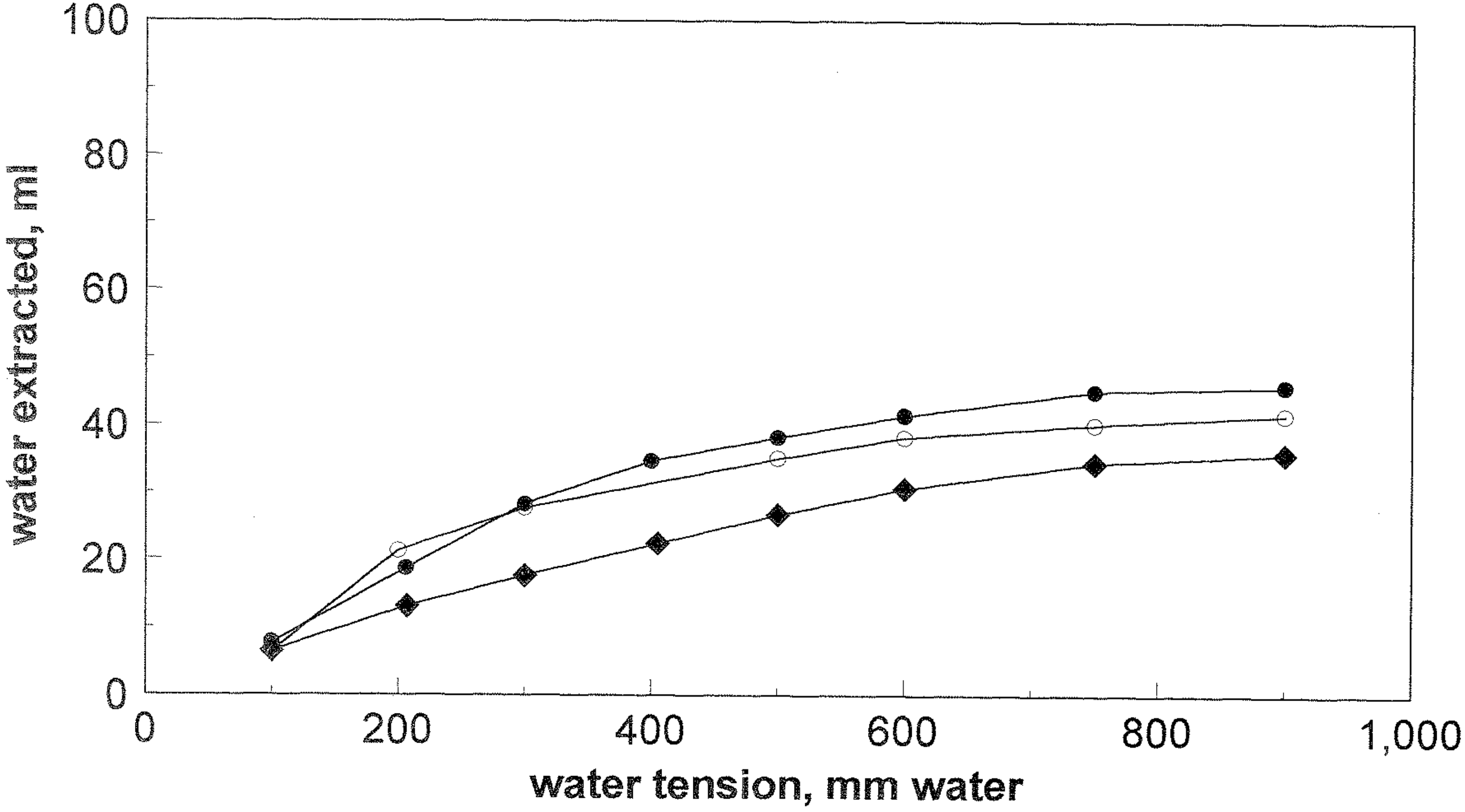
1. Shamrock brown milled



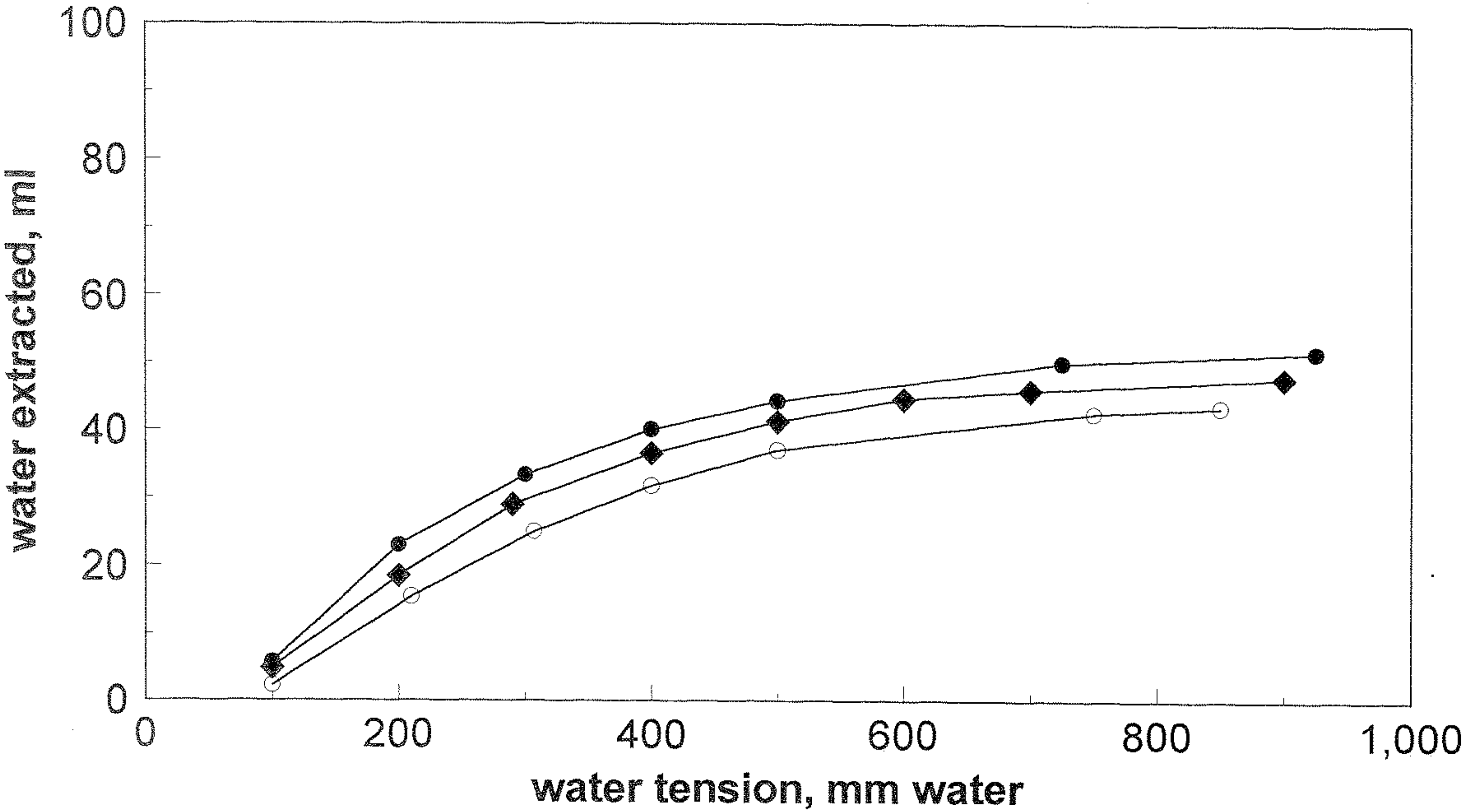
2. Shamrock black milled



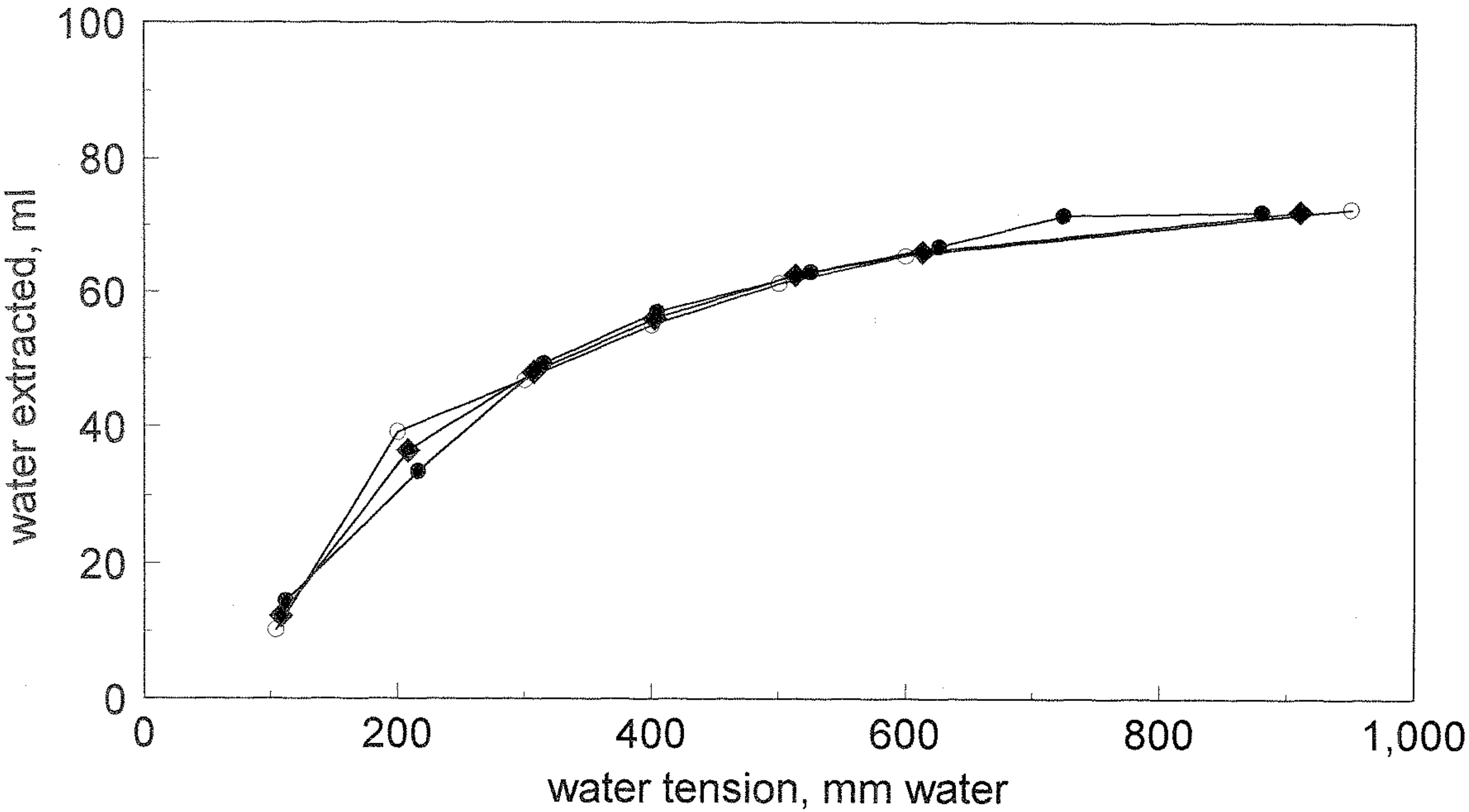
3. Shamrock black bulk



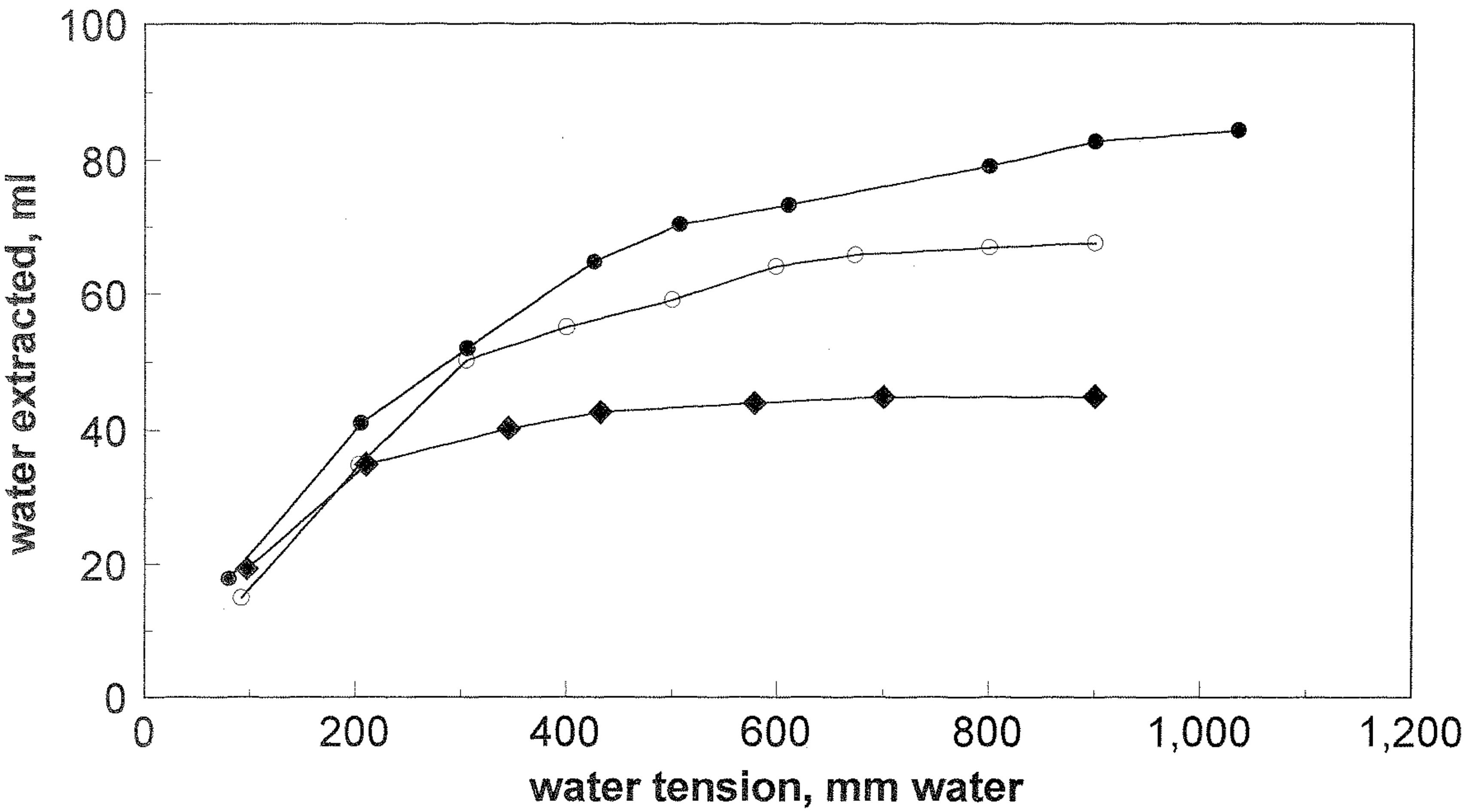
4. Shamrock black bulk dried



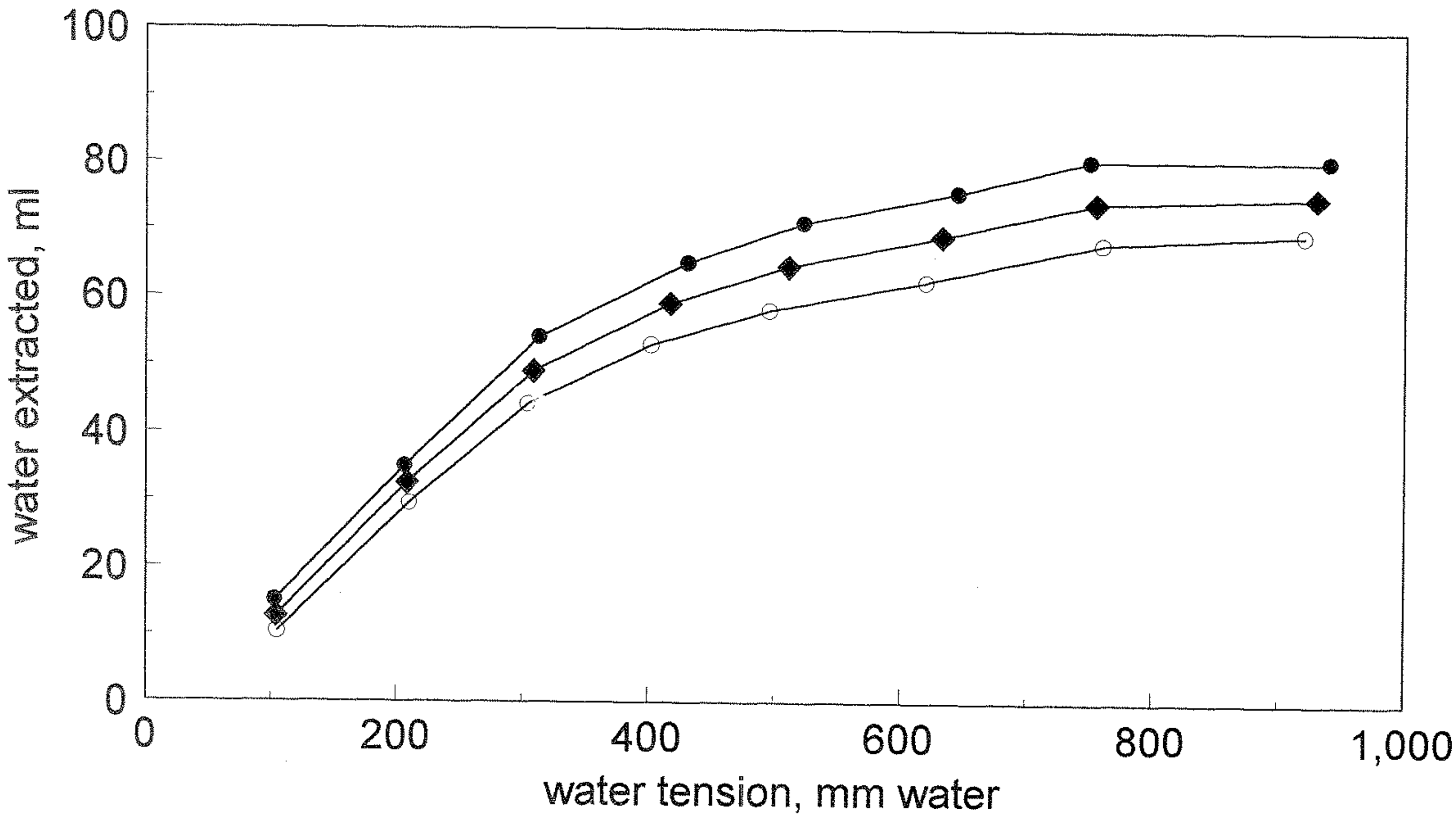
5. Novobalt sphagnum fine grade



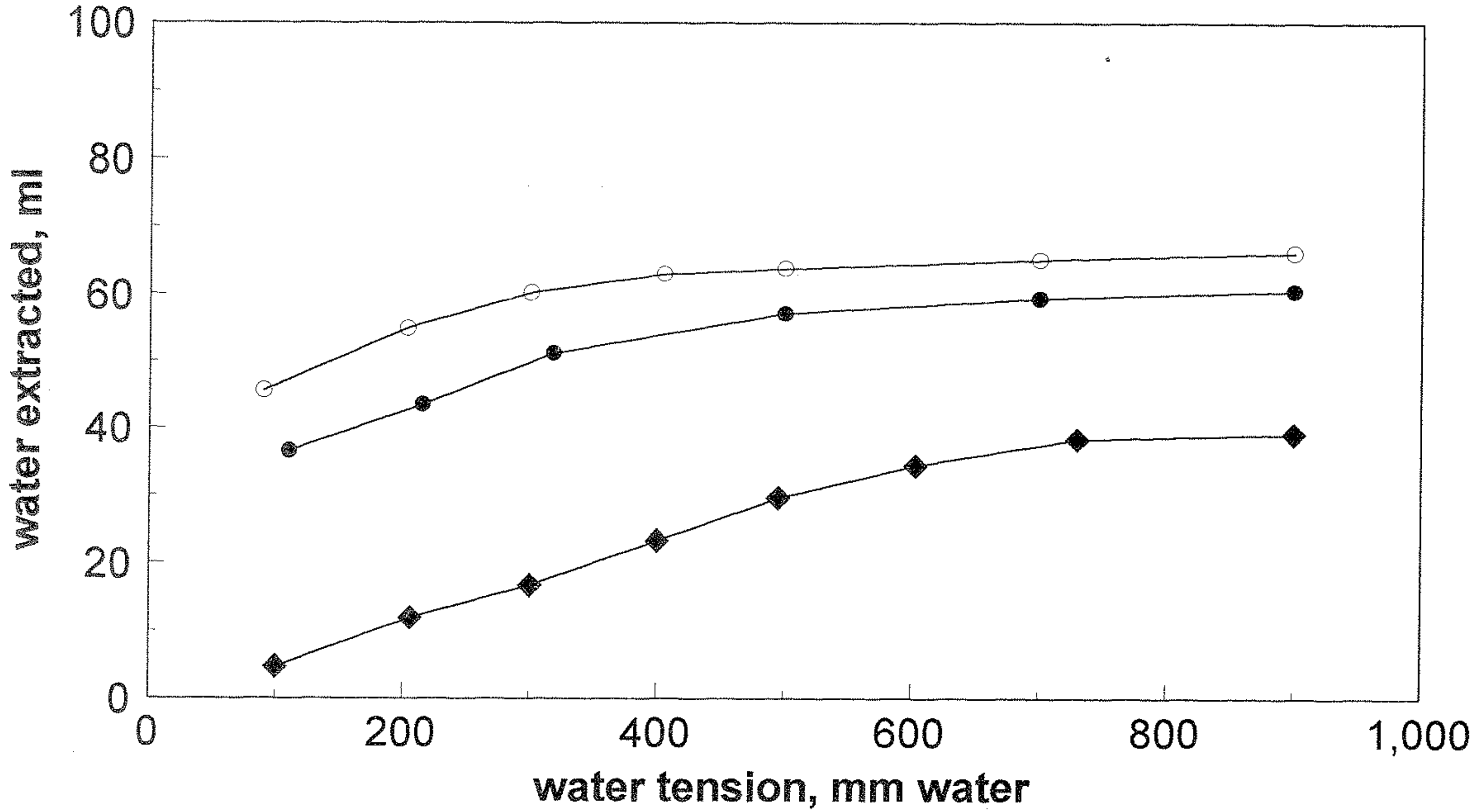
6. Novobalt medium grade



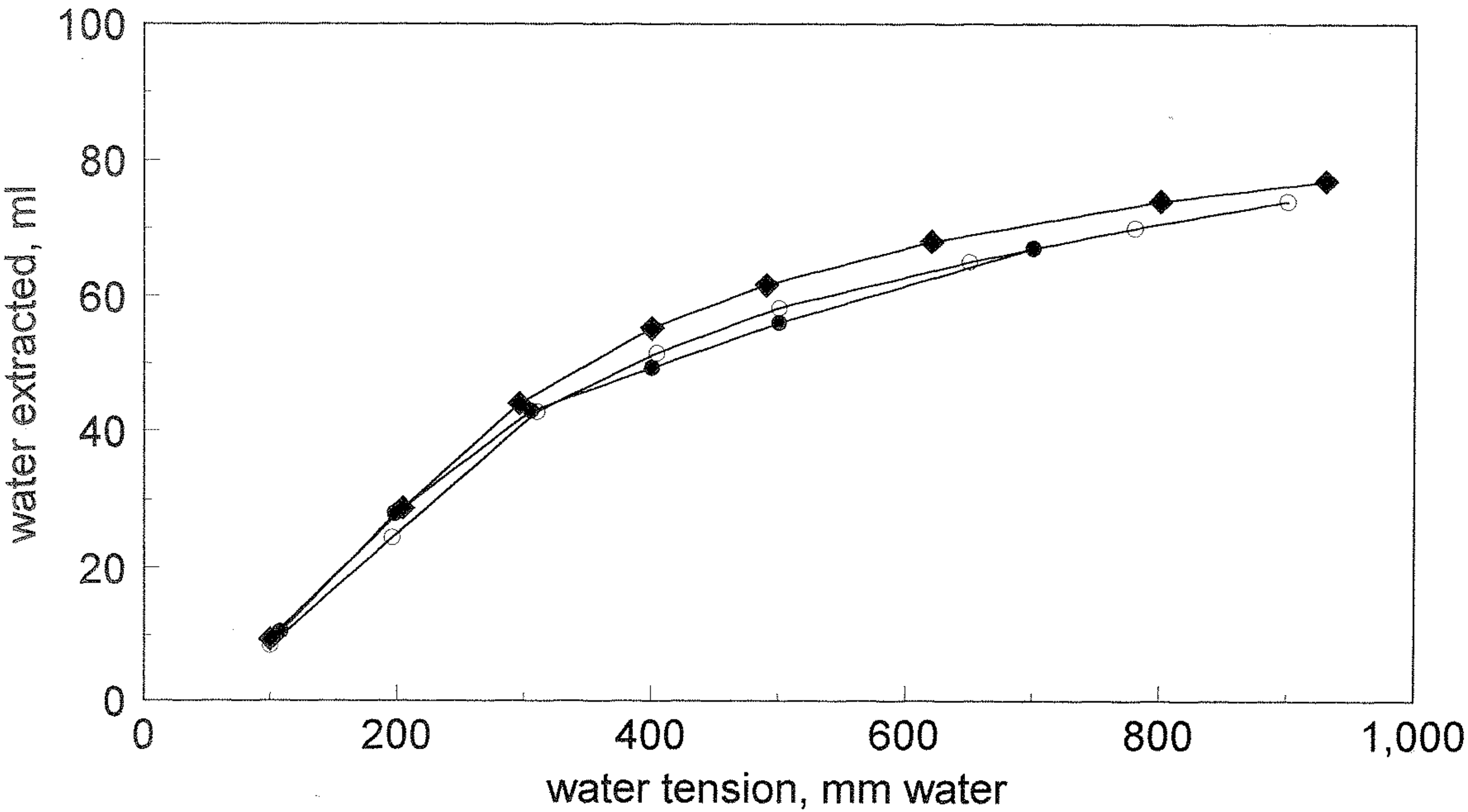
7. Euroveen white milled



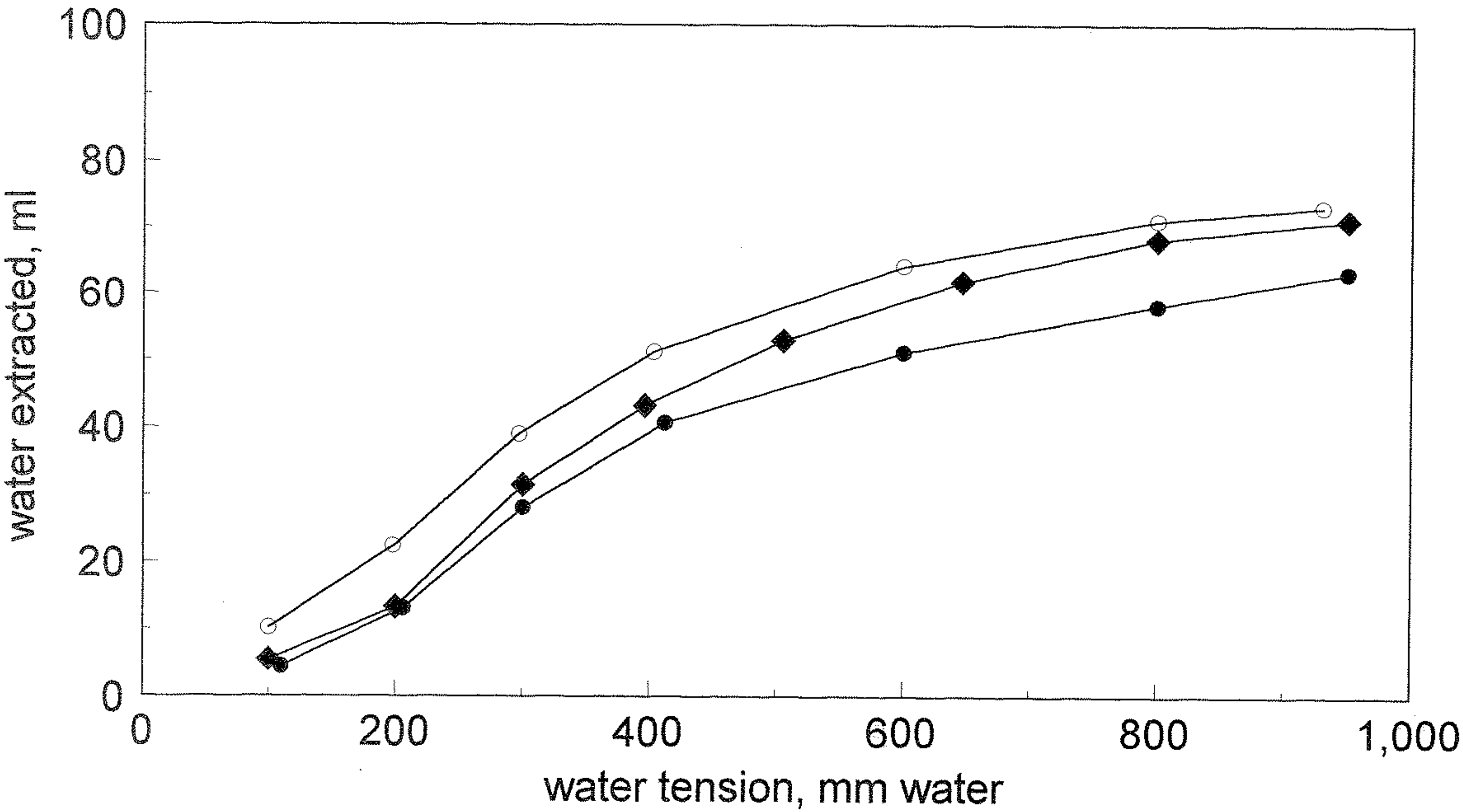
8. Euroveen black



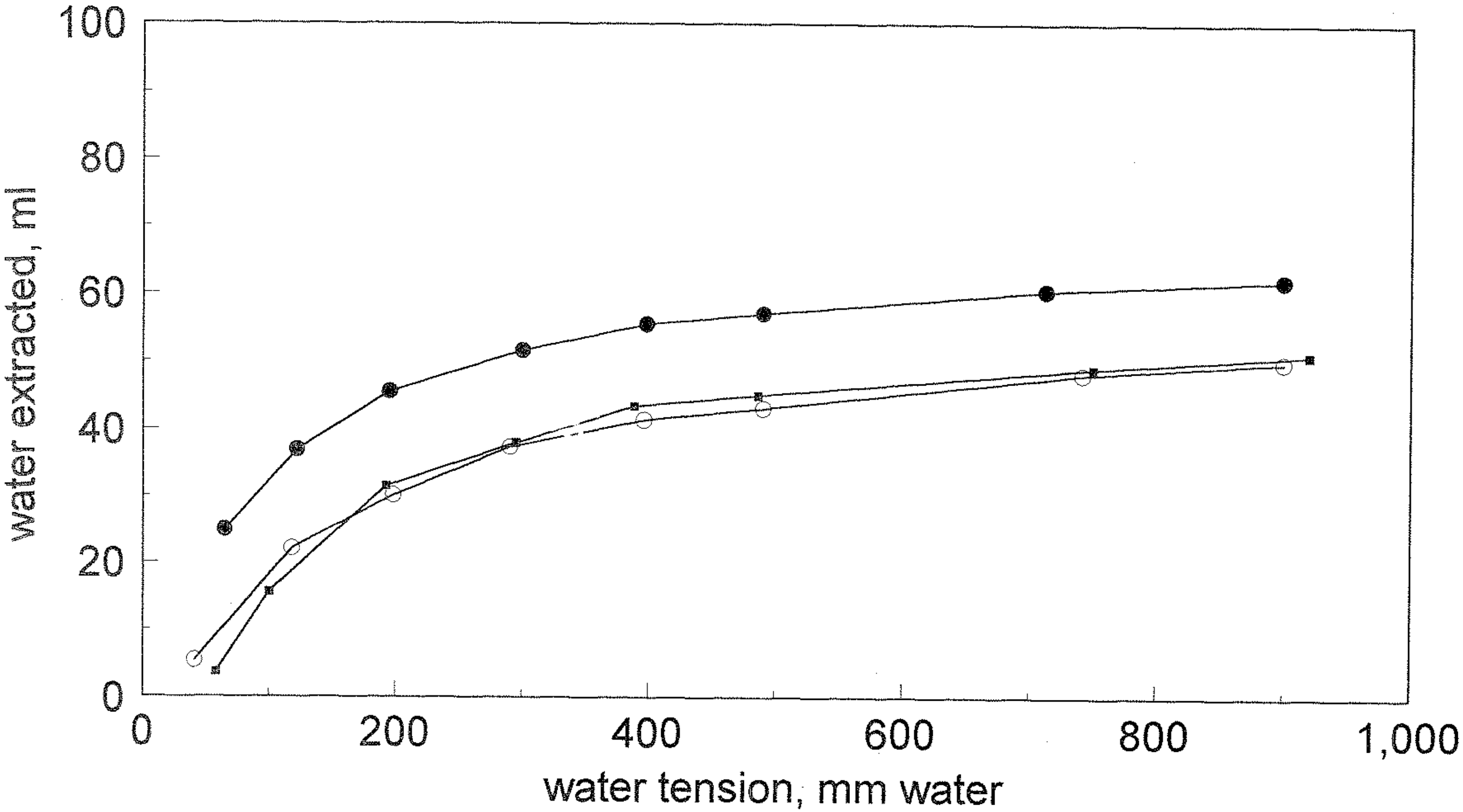
9. Vapo black milled



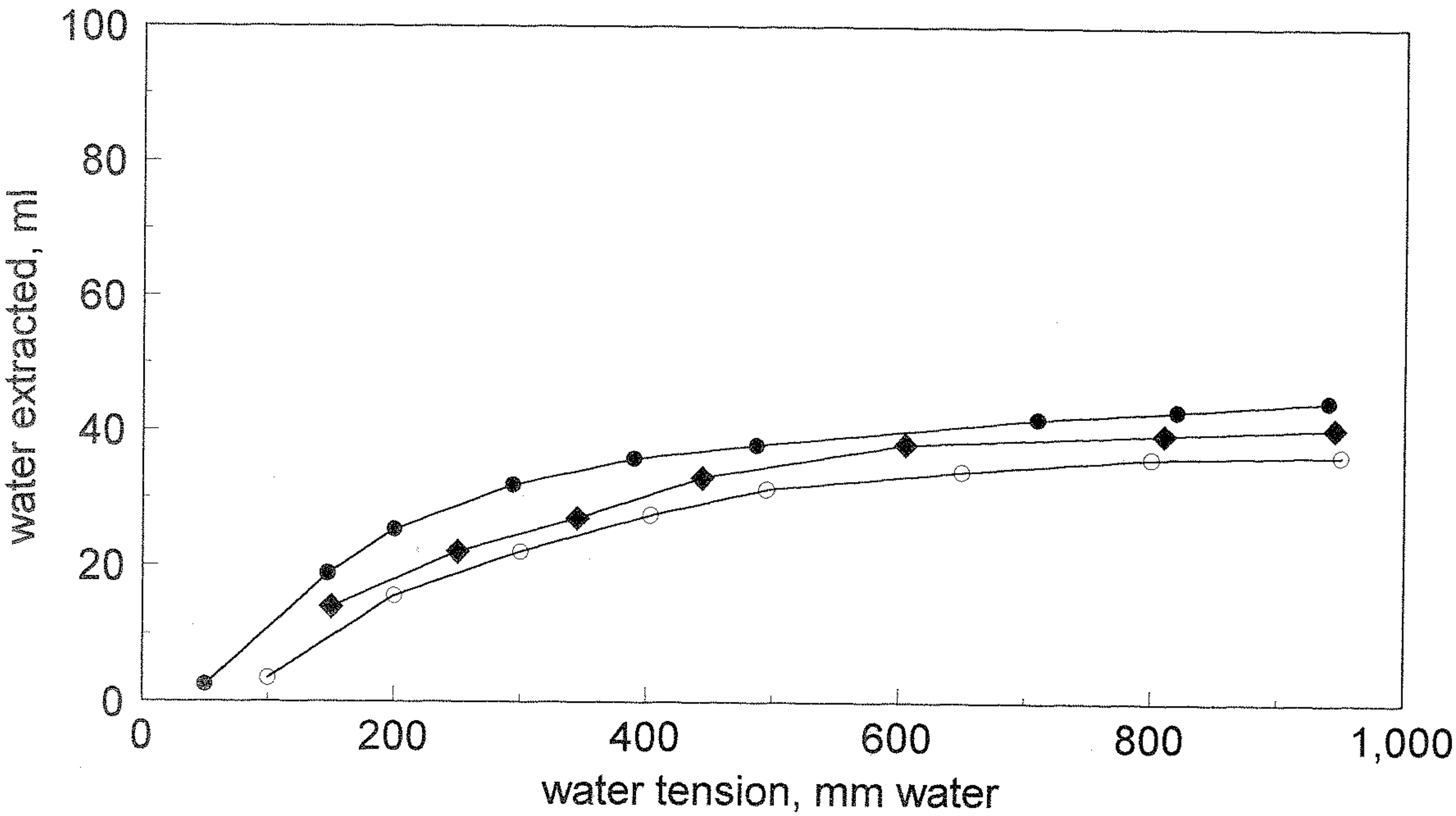
10. Vapo brown milled



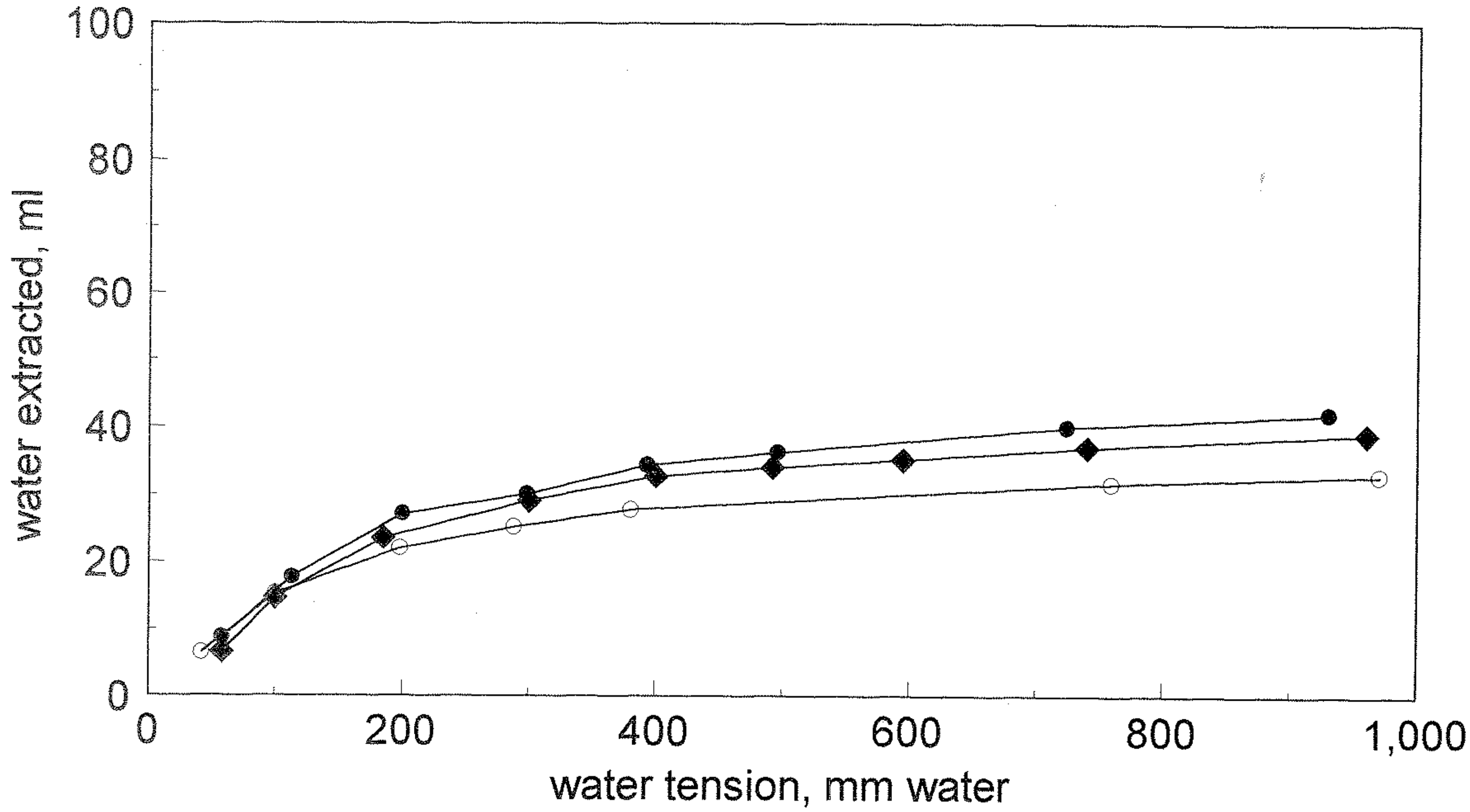
11. Harte brown bulk



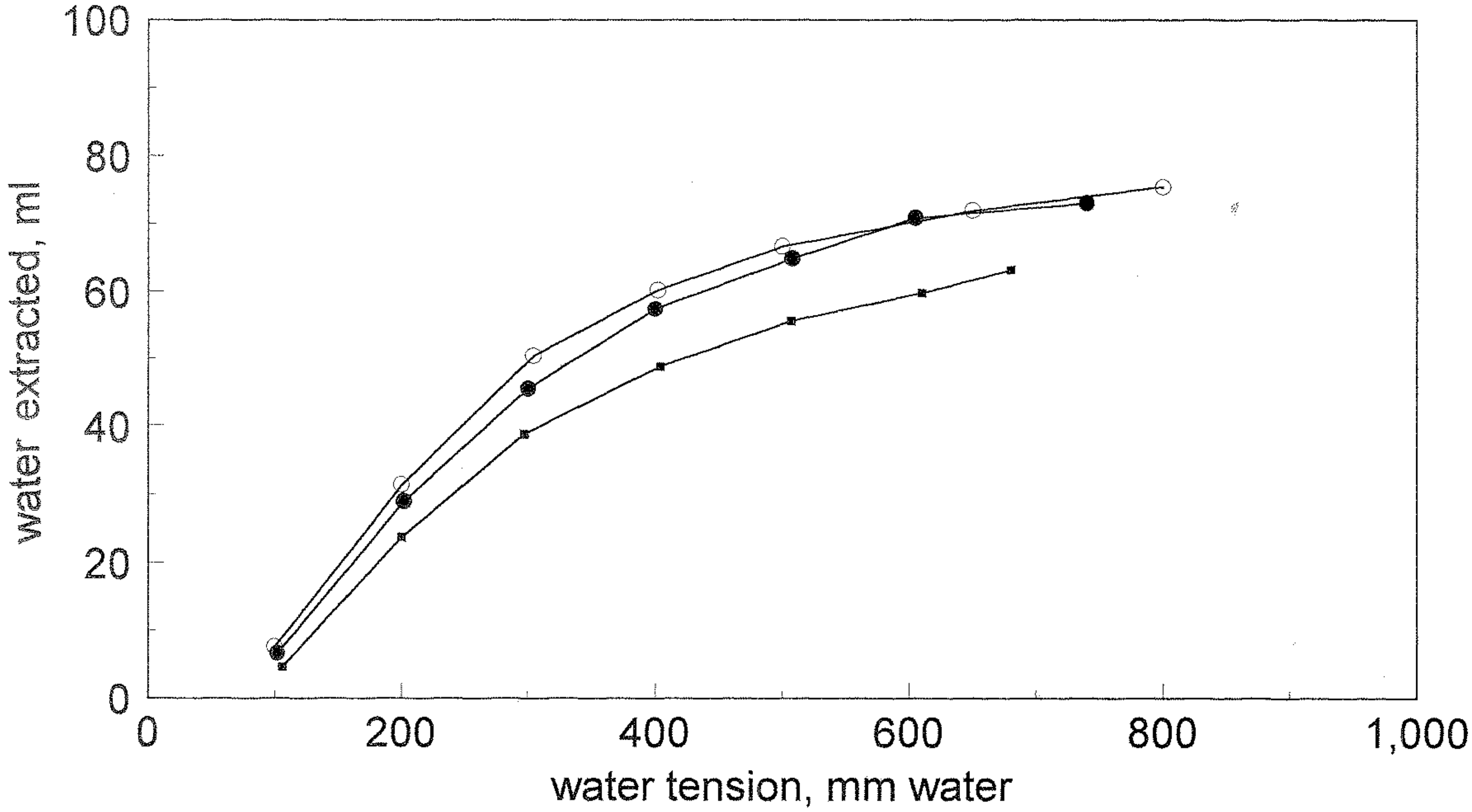
12. Harte black bulk



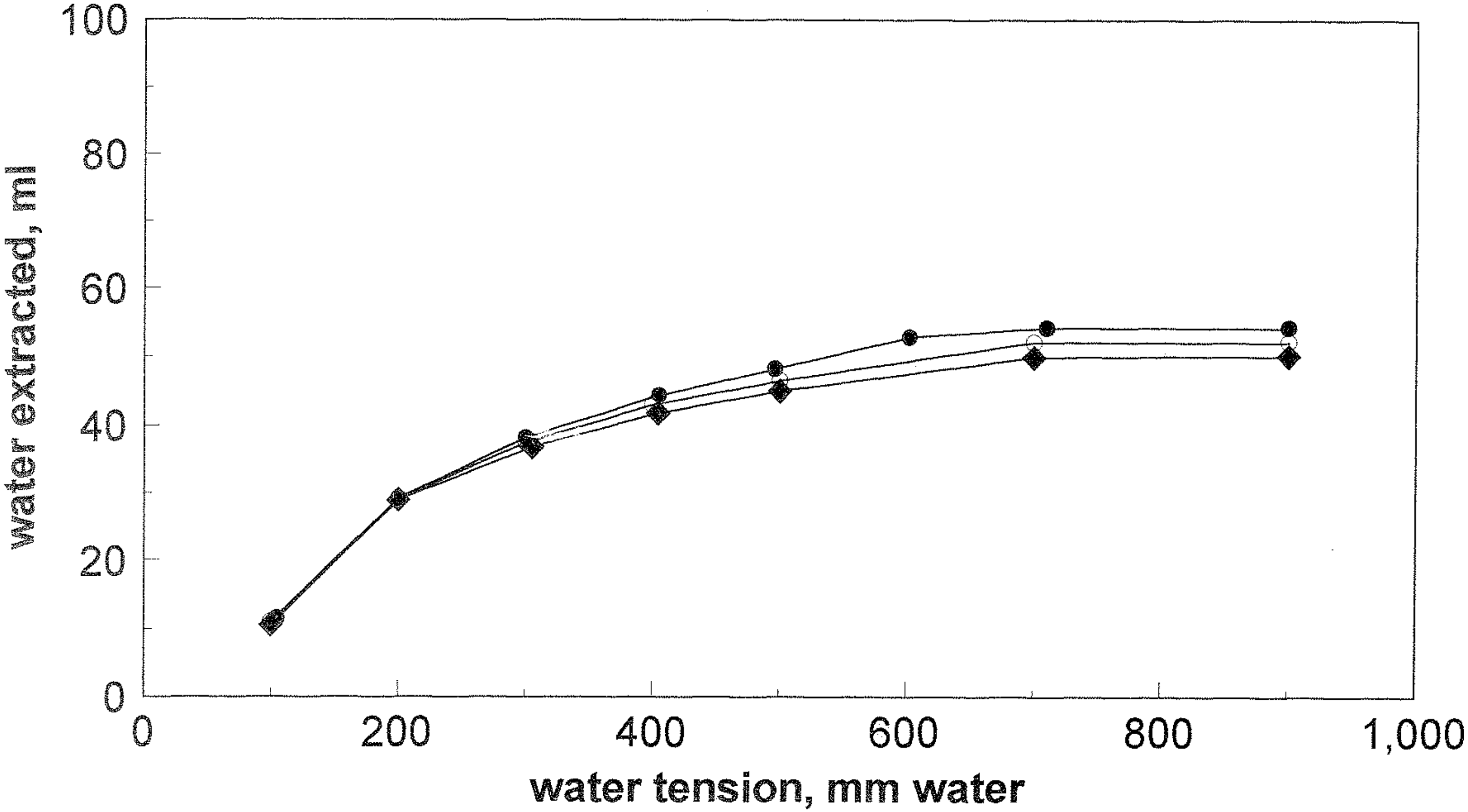
13. Harte black milled



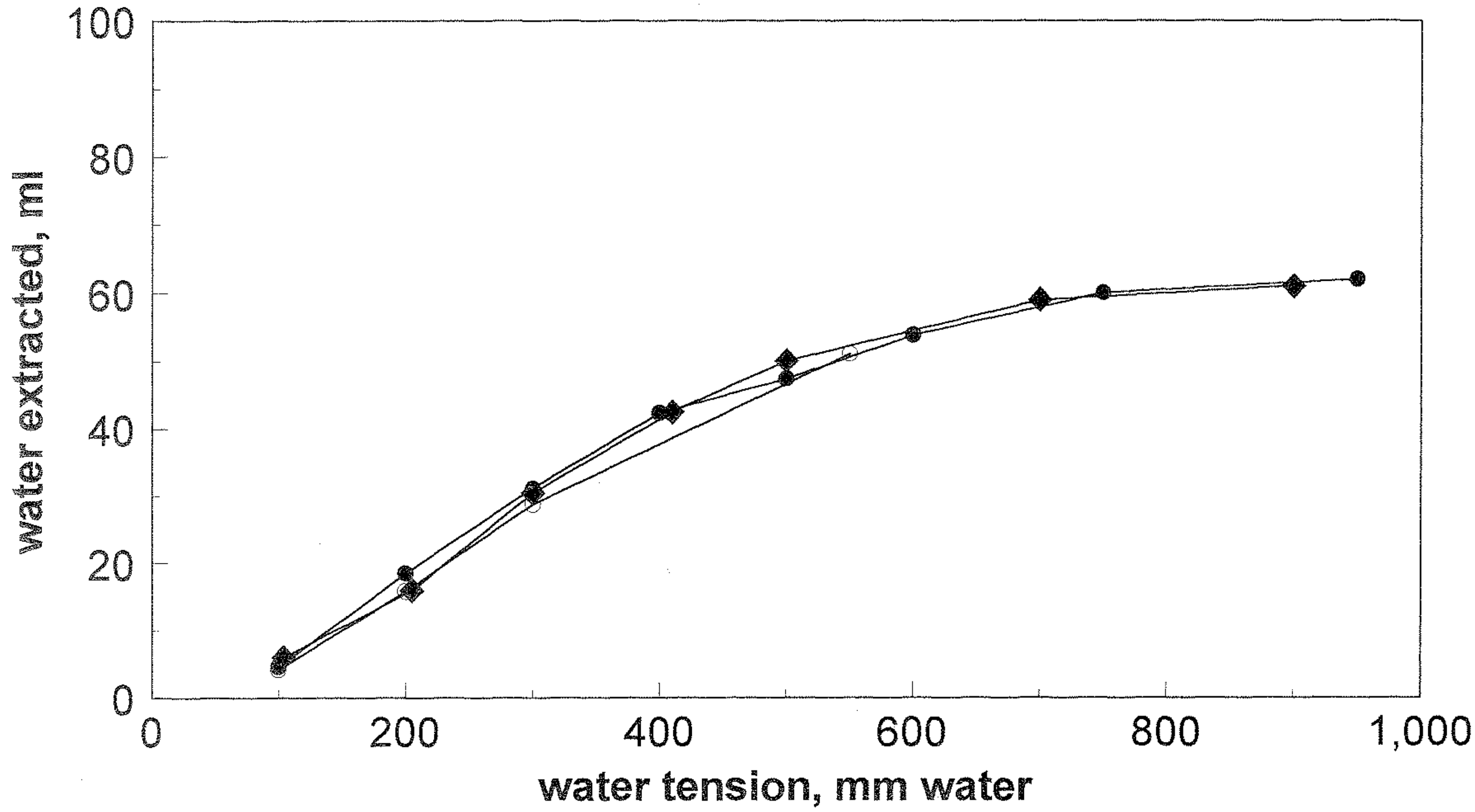
14. L&P Sphagnum milled



15. L&P economy

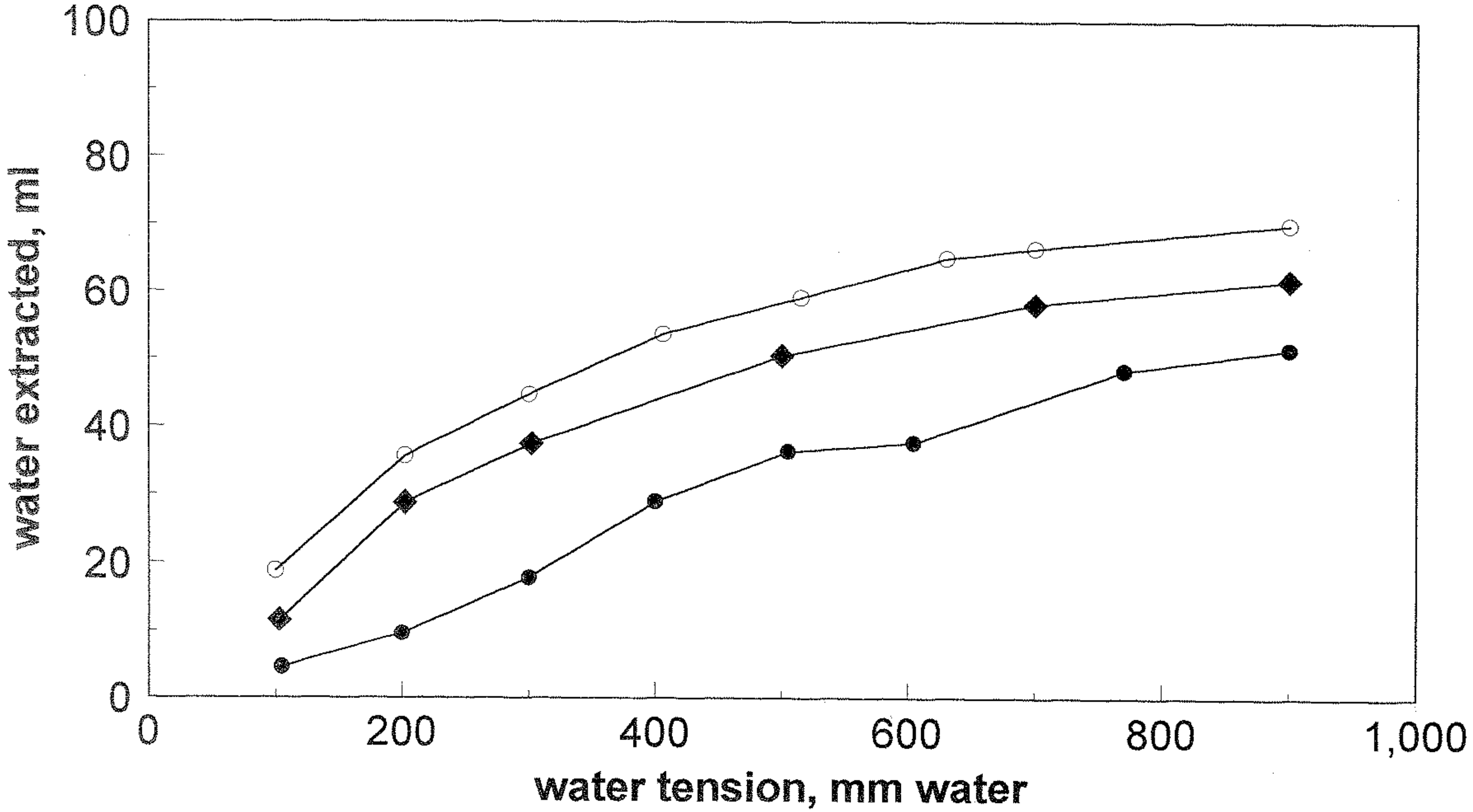


16. L&P milled



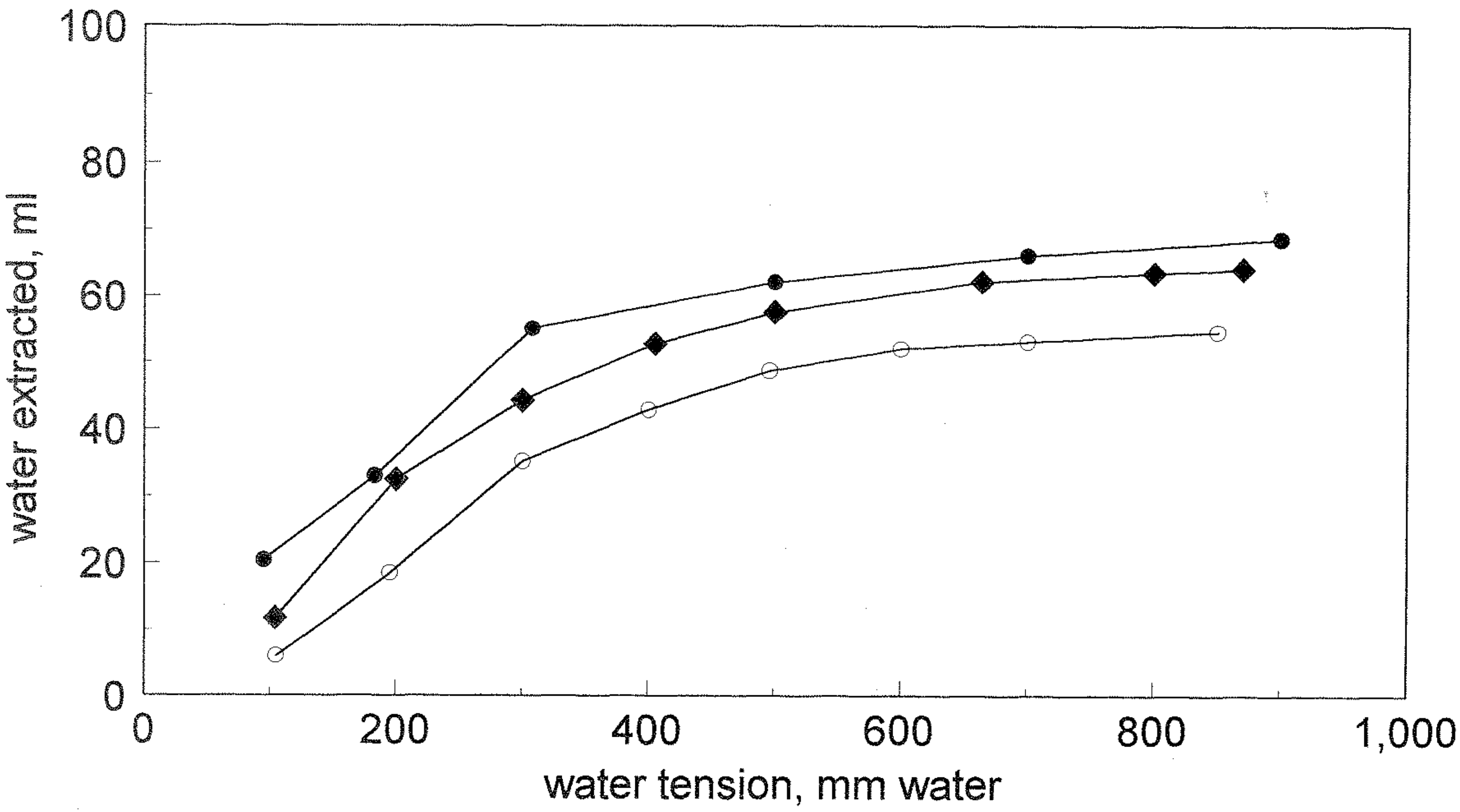
100
80
60
40
20
0
water extracted, ml
0
200
400
600
800
1,000
water tension, mm water

17. L&P wet

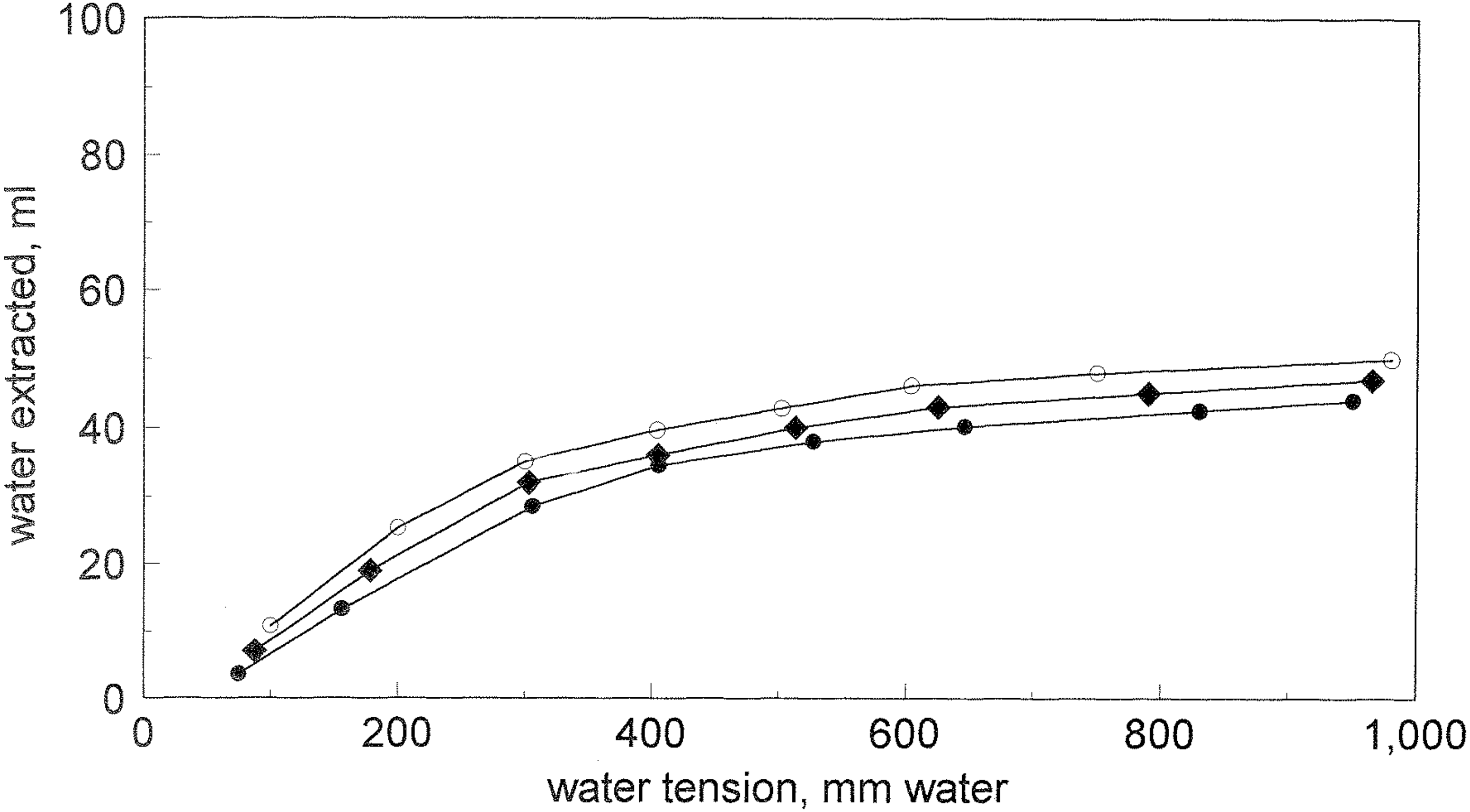


water extracted, ml
100
80
60
40
20
0
0
200
400
600
800
1,000
water tension, mm water

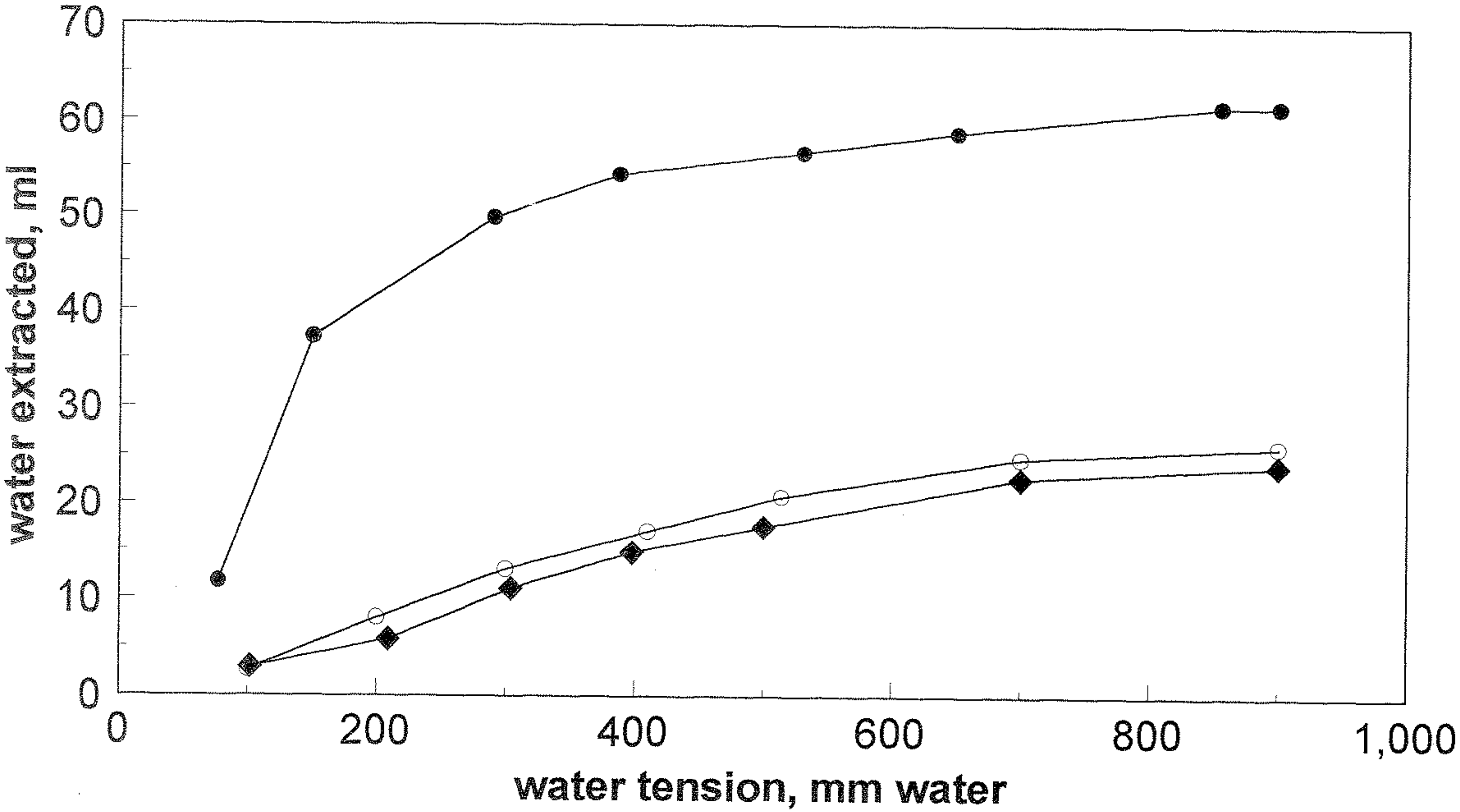
18. Levington milled sphagnum



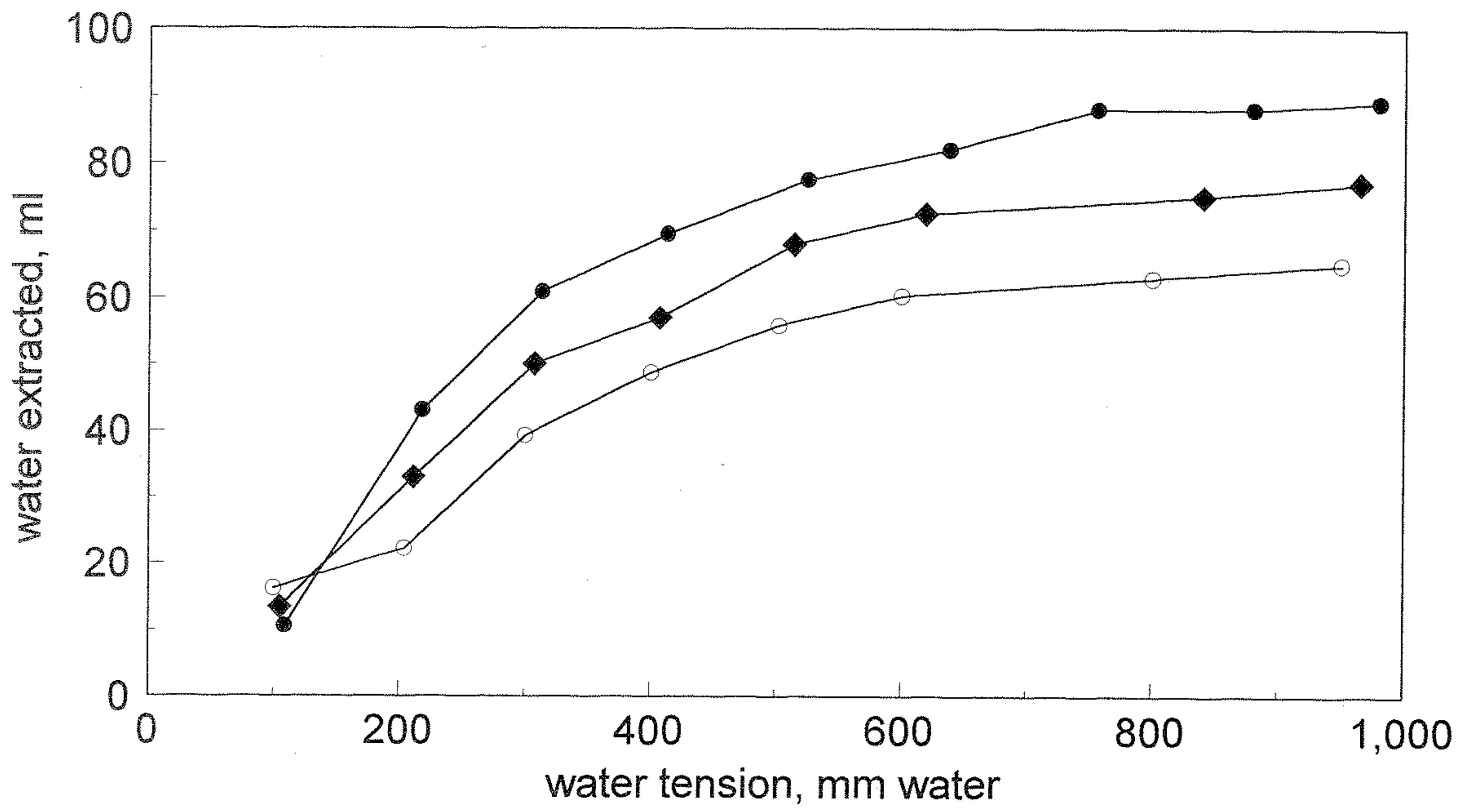
19. Levington brown wet bulk



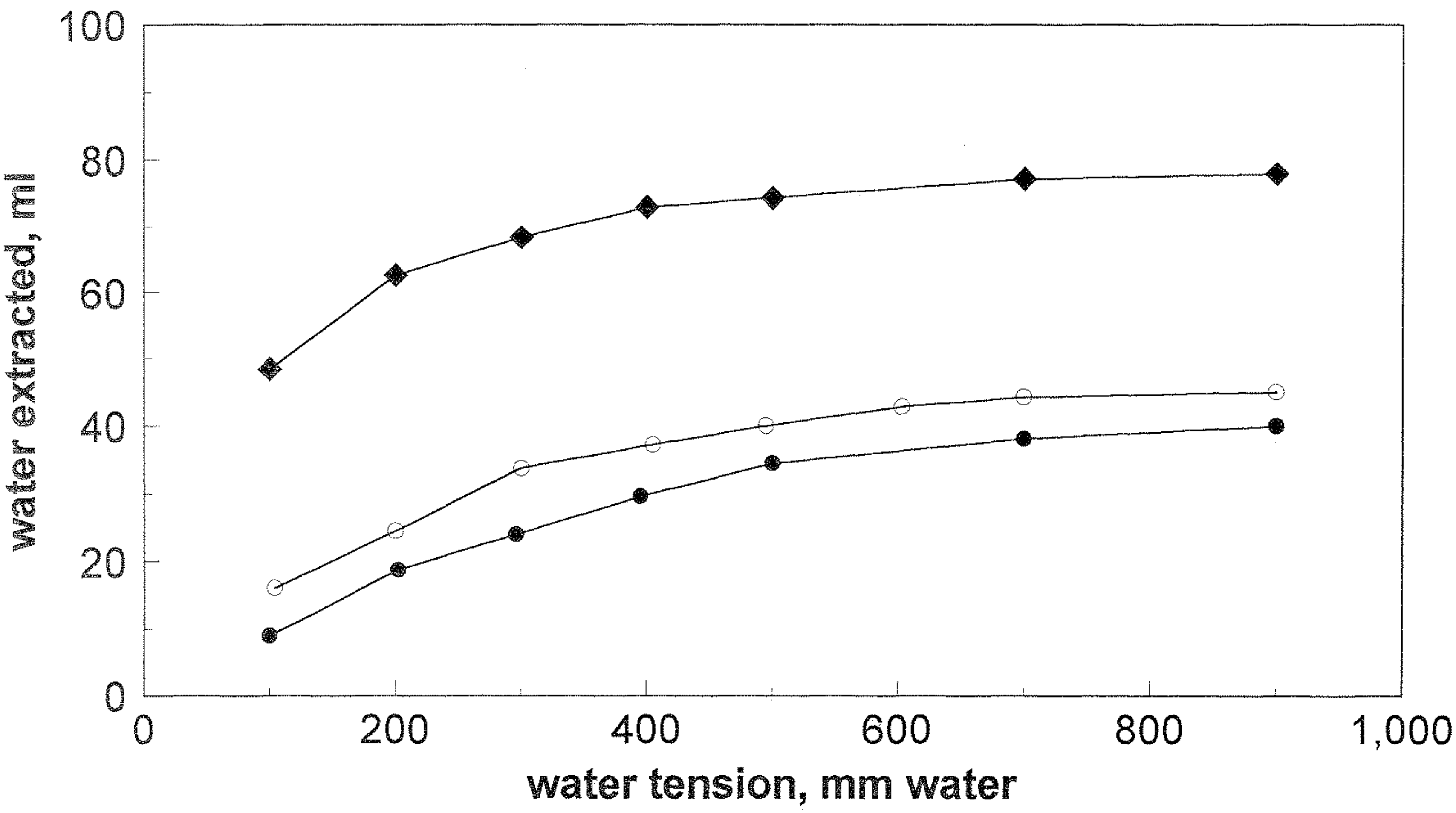
20. Nooyen black



21. Nooyen white

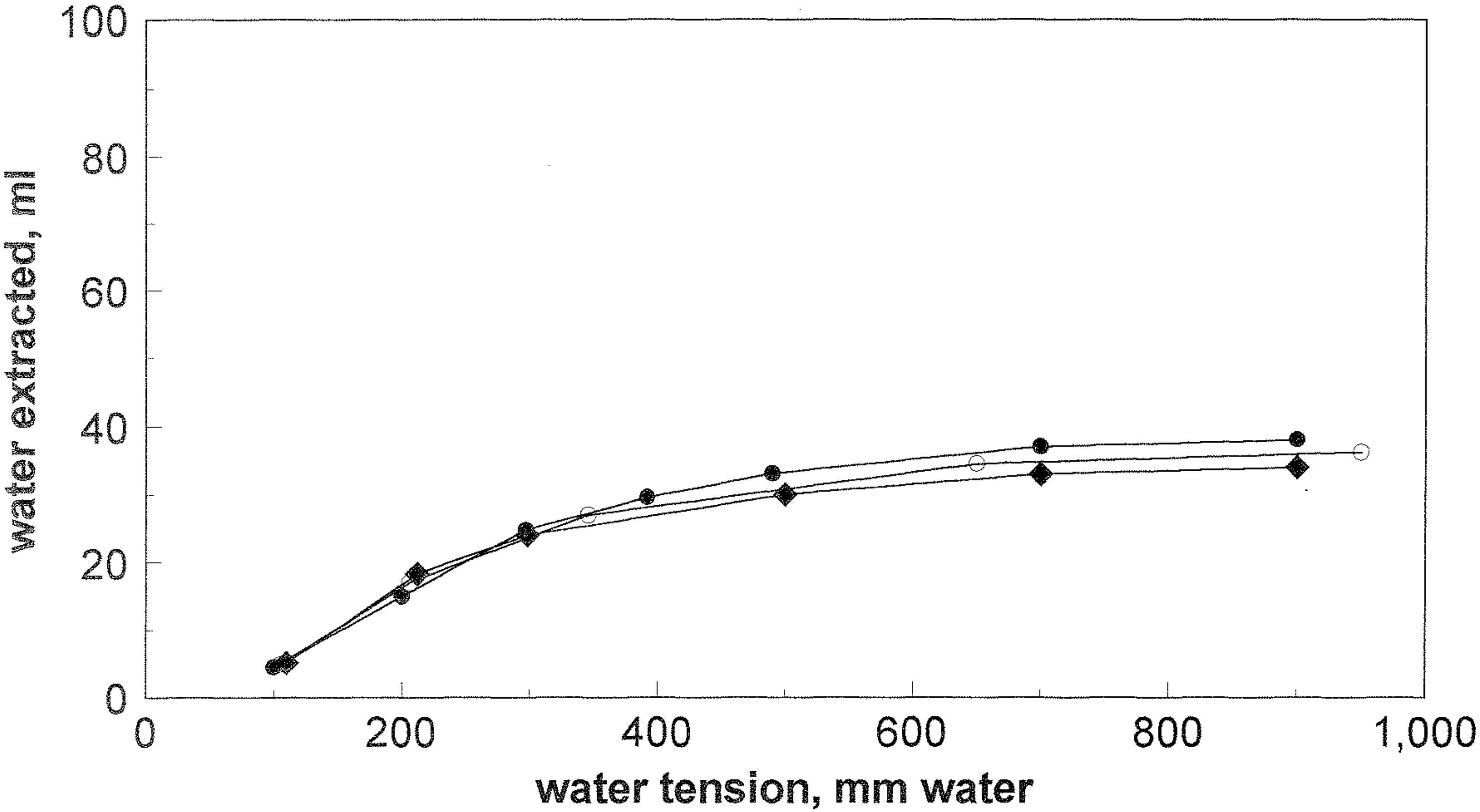


22. Prunty



water extracted, ml
100
80
60
40
20
0
0
200
400
600
800
1,000
water tension, mm water

23. Wilmslow


100
80
60
40
20
0
water extracted, ml
0
200
400
600
800
1,000
water tension, mm water

Contract No: M20b

1. TITLE OF PROJECT

Properties of Peat Sources Used in Mushroom Casing.

2. BACKGROUND AND COMMERCIAL OBJECTIVE

An HDC funded survey of UK mushroom casing materials (Project M20) showed that a wide range of peats are used. The materials range from sphagnum peats, through intermediates, to sedge peats. The level of decomposition ranges from black, deep-dug peats to younger surface peats. Two methods of peat extractions, milling and bulk extraction, are also used.

Preliminary analyses in Project M20a showed significant differences in physical and chemical properties of the peat sources. Before further experiments to determine the performance of peat sources in mushroom casing are carried out, the properties of peat sources currently used will be assessed.

The work will enable growers to relate their type of peat to those used in HDC funded experiments, since it will only be possible to include a limited range of peat sources in the trials.

3. POTENTIAL FINANCIAL BENEFIT

The selection of optimum peat sources or types will enable the mushroom industry to achieve consistently better yields and quality.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

To determine specified physical and chemical properties of a range of peat sources or types currently used in the UK mushroom industry.

5. CLOSELY RELATED WORK

The HDC is currently commissioning a series of trials to investigate the effects of casing materials and casing management techniques on the yield and quality of mushrooms. As well as peat sources, this work is investigating the influences of lime sources and casing depth and moisture content on mushroom yield and quality.

6. DESCRIPTION OF THE WORK

The following properties will be determined on peat samples:

<u>Physical properties</u>

(i) Moisture content
(ii) Water retention
(iii) Water release characteristics
(iv) Bulk density, dry and wet
(v) Air filled porosity

Chemical properties

(i) pH
(ii) Conductivity
(iii) Ash content

Three replicate samples of each peat source will be analysed. A total of 20 peat sources will be assessed.

7. COMMENCEMENT DATE, DURATION AND REPORTING DATE

Commencement date: 1 February 1996, Duration 6 months.
Final report: end of July 1996

8. STAFF RESPONSIBILITIES

Project Leader: R. Noble
Project Co-ordinator: T. Haynes

9. LOCATION

HRI Wellesbourne