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⑤4 Virsraksts: Vienkameron kungā lauksaimniecības dzīvnieku barībai pievienojamo labības graudu sasmalcināšanas paņēmieni

⑤7 Kopsavilkums: Izgudrojums attiecas uz labības graudu, kurus pievieno vienkameron kungā lauksaimniecības dzīvnieku, īpaši cūku, barībai, sasmalcināšanas paņēmieni. Labības graudus sasmalcina sausajā veltnu drupinātājā tā, lai vairāk kā 50 masas % sasmalcināto graudu būtu ar daļiņu izmēru no 1 līdz 5 mm un daļiņu kumulatīvā porainība pie poru diametra robežās no 0,01 līdz 10 m būtu 0,08 līdz 0,2 cm³/g, tādējādi ar sasmalcinātajiem graudiem samazinot barības trakta bojājumus bez gremošanas pasliktinājuma.

Tālāk izgudrojums attiecas uz cūkām paredzēto sasmalcināto barību, kur labības graudus sasmalcina sausajā veltnu drupinātājā, lai iegūtu rupjās daļiņas, no kurām vairāk kā 50 masas % būtu ar izmēru no 1 līdz 5 mm un daļiņu kumulatīvā porainība pie poru diametra robežās no 0,01 līdz 10 m būtu 0,08 līdz 0,2 cm³/g

IZGUDROJUMA FORMULA

1. Vienkameronas kuņģa lauksaimniecības dzīvnieku, īpaši cūku, barībai pievienojamo labības graudu sasmalcināšanas paņēmieni, *a t š ķ i r a s* ar to, ka labības graudus sasmalcina sausajā veltnu drupinātājā rupja maluma daļiņās tā, lai vairāk kā 50 svara % sasmalcināto graudu būtu ar daļiņu izmēru 1- 5 mm un daļiņu kumulatīvā porainība pie poru diametra 0,01 - 10 μm būtu 0,08 - 0,2 cm^3/g , ieteicamāk 0,09 - 0,15 cm^3/g , tādejādi ar sasmalcinātajiem graudiem samazinot barības trakta bojājumus, nepasliktinot gremošanu.

2. Paņēmieni saskaņā ar 1. punktu, kas *a t š ķ i r a s* ar to, ka vairāk kā 50 svara % sasmalcināto graudu ir ar daļiņu izmēru 1 - 4 mm, ieteicamāk vairāk kā 60 % ar daļiņu izmēru 1 - 3 mm.

3. Paņēmieni saskaņā ar 1. vai 2. punktu, kas *a t š ķ i r a s* ar to, ka sasmalcināto graudu vidējais daļiņu lielums DP_m ir 1 - 4, ieteicamāk 1,5 - 2,5 mm.

4. Paņēmieni saskaņā ar jebkuru iepriekšminēto punktu 1 - 3, kas *a t š ķ i r a s* ar to, ka sasmalcināšanai izmantotā labība ir kvieši, mieži un/vai kukurūza.

5. Paņēmieni saskaņā ar jebkuru no iepriekšminētajiem punktiem 1 - 4, kas *a t š ķ i r a s* ar to, ka sasmalcināšanu veic kā auksto veltnēšanu.

6. Paņēmieni saskaņā ar jebkuru no iepriekšminētajiem punktiem 1 - 5, kas *a t š ķ i r a s* ar to, ka sasmalcina labību, kuras mitruma saturs ir mazāks kā apmēram 15 %.

7. Cūkām paredzētā labība, kura satur sasmalcinātus graudus, *a t š ķ i r a s* ar to, ka labība sasmalcināta sausajā veltnu drupinātājā, lai iegūtu rupjās daļiņas, no kurām vairāk kā 50 svara % ir daļiņas ar izmēru 1 - 5 mm, ieteicamāk 1 - 4 mm, visieteicamāk vairāk kā 60 % ir daļiņas ar izmēru 1 - 3 mm un daļiņu kumulatīvā porainība pie poru diametra no 0,01 - 10 μm ir 0,08 - 0,2 cm^3/g , ieteicamāk 0,09 - 0,15 cm^3/g , tādejādi cūkām paredzētā barība samazina barības trakta bojājumus, nepasliktinot gremošanu.

8. Cūkām paredzētā labība saskaņā ar 7. punktu, kas atšķiras ar to, ka labības produkts ir kvieši, mieži un/vai kukurūza.

9. Paņēmiens cūku barības trakta bojājumu samazināšanai, izmantojot barību, kura satur sasmalcinātus graudus, nepasliktinot barības gremošanu, atšķiras ar to, ka cūkām paredzētajai barībai pievieno sausajā veltnu drupinātājā sasmalcinātus graudus, lai iegūtu daļiņas, no kurām vairāk kā 50 svara % ir daļiņas, kuru izmērs ir 1 - 4 mm, ieteicamāk vairāk kā 60 svara % ir daļiņas, kuru izmērs 1 - 3 mm un daļiņu kumulatīvā porainība pie poru diametra 0,01 - 10 μm ir 0,08 - 0,2 cm^3/g , ieteicamāk 0,09 - 0,15 cm^3/g .

10. Paņēmiens saskaņā ar 9. punktu, kas atšķiras ar to, ka cūkām paredzētajā barībā izmanto kviešus, miežus un/vai kukurūzu.

PROCEDURE FOR COMMINUTING CEREAL GRAINS TO BE ADMIXED
TO THE FEED OF A SINGLE-STOMACH PRODUCTION ANIMAL

5 The present invention concerns a procedure
for comminuting grains of cereal to be admixed to the
feed of single-stomach production animals, in particu-
lar pigs.

10 Cereal is raw material commonly used in pig
feed. Grinding the grains of cereal to be admixed to
the feed has been found, according to general under-
standing, to improve the utilization of cereal with
pigs of all ages. Studies relating to the effect of
15 grinding coarseness of cereal have revealed that bet-
ter growth results, generally considered, are achieved
with fine-ground feed. It has further been found that
the more finely divided the meal the larger is the
total surface area of the meal exposed to digestion
enzymes, and the better its digestibility.

20 Present practice is generally to use in pig
feeds cereal processed in a hammer mill to fine-ground
state, in view of its good digestibility and good
granulability. Good growth results are obtained with
such feed, and it is therefore used in power-feeding
25 pigs.

 The problem is, however, that such feed used
in power feeding produces damage of various degrees in
the pigs' digestive tracts. Such damage includes gast-
ric ulcer, which has been found to be of two different
30 types: ulcer of the glandular part and of the non-
glandular part, and milder changes in the intestinal
wall, which may further progress to intestinal inflam-
mation. According to various studies serious changes
detrimental to the pig's comfort and well-being occur
35 in 10 to 20% of pigs. According to a Finnish investi-
gation, 20% of the mortality of meat pigs are due to
gastric ulcer.

Commonly, the most important cause responsible for development of digestive tract damage is considered to be the physical and chemical composition of the feed. Other causes are various stress factors, such as small pens, competition situation, humidity, poor ventilation, long transport distances and/or prolonged period in the slaughterhouse. Attempts have been made to eliminate the problem by adding feed raw material rich in fibre. But the problem could not be solved by this approach. The utilizability of feed produced in this way has been low and the effect on productivity has likewise been low.

The digestive tract-damaging effect of feed such as is used at present has been estimated to be due, in particular, to the finely divided cereal meal contained in the feed.

Various studies have shown the connection between cereal grain particle size and gastric ulcer. There is one study which reports increased fluidity of the stomach contents caused by finely ground cereal, whereby the stomach contents become more powerfully mixed. As a consequence, the stomach contents containing HCl and pepsin come into contact with the nearly unprotected stomach wall, causing damage there.

Coarse grinding of cereal is known to reduce the incidence of gastric ulcer cases clearly, but on the other hand the digestibility of coarse-ground cereal is not good enough with a view to power feeding. Cereal meal which has been left coarser in hammer mill grinding, which has a reduced total surface area of its particles, is inferior in digestibility to cereal which has been fine-ground. Further, coarser cereal used for chickens and steam-rolled cereal used for neat livestock have been tried out on pigs, but these too have yielded inferior digestibility, compared with presently used pig feed rich in cereal ground to fine division in the hammer mill.

Therefore the cereal going to be admixed to pig feed has even further been ground to a degree of comminution involving damage to the digestive system, for the reason that in spite of stomach damage the best growth results are achieved with it.

It is however questionable to use pig feed which may cause pathological, painful damage to the pigs even though this damage might not have any influence on the growth results of the animals.

The object of the present invention is elimination of the drawbacks held forth in the foregoing.

The object of the invention is, specifically, to disclose a procedure which enables cereal meal to be admixed to pig feed and/or granulated together therewith by means of which the effects damaging the digestive tract can be reduced compared with the cereal meal heretofore used in power feeding, and by means of which in addition an optimal growth result can be achieved.

The object of the invention is furthermore to disclose cereal meal comminuted by a procedure according to the invention which can be admixed to pig feed meant for power feeding, and pig feed thus obtained.

The object of the invention is moreover to disclose a procedure by which the effects damaging the digestive tract of pig feeds used in power feeding can be significantly reduced without thereby impairing the digestibility of the feed.

Regarding the features characterizing the invention reference is made to the claims.

It has been found in studies made in connection with the invention that when in pig feed cereal meal is used which has been comminuted or ground as taught by the invention in a dry roll grinder, it becomes possible to reduce efficiently the digestive tract damage occurring in pigs, which is encountered when using fine-ground cereal meal. Furthermore, the

digestibility of the coarsely divided cereal meal of the invention has been found to be at least equal to that of the more finely divided cereal meal heretofore used in power feeding.

5 It was found in studies that were carried out that the structure of cereal can by dry roll grinding be changed without reducing the pore volume of the particles. In actual fact, coarsely divided cereal
10 particles can be produced by the procedure of the invention which have a pore volume which is consistent with the pore volume of the particles of cereal ground fine in a hammer mill, such as is used in pig feed at present.

15 The unexpectedly large pore volume of the particles of cereal ground as taught by the invention has been found to be due to the fact that the grains are flattened in the dry roll grinder and their surface structure cracks and/or becomes pleated, adding
20 amply to the pore volume of the particles. In the cereal particles pores are formed owing to said cracking and/or pleating, which increase the surface area of the particles and the volume of the gaps or pores that are formed.

25 In the literature the effects of cereals ground by different grinding methods have only been studied as regards digestibility of the feed and the pigs' growth. Fairly few studies have been reported, and the results reported are somewhat controversial, perhaps owing to different conditions of experiment.
30 For instance, in the experiments reported in the references: Lawrence, T.L.J., Some effects of including differently processed barley in the diet of the growing pig, Growth rate, food conversion efficiency, digestibility and rate of passage through the gut, Anim.
35 Prod. (1970) 12:139-150, and Haugse et al., Effect of physical form of barley in rations for fattening pigs. N. Dakota Agric. Exp. Stat. Res. Rep. No. 17 (1966),

similar, or slightly better, results were obtained with cold rolling than with hammer mill grinding. The authors concluded on the strength of the results, in a general way, that in addition to the coarseness grade of the meal there are other factors affecting the production results, such as the surface configuration of the feed particles. In the publication: Frabe et al., Effect of processing barley and of delayed concentrate feeding on growth and nutrient balance in growing pigs and the effect of processing barley on apparent digestibility of pregnant sows. J. Anim. Sci. 27: 1313-1319 (1968), on the other hand, experimental results are reported according to which there was only a minor difference in digestibility between altogether unground and cold-rolled barley. According to the results reported in: Madsen et al., Høsttids- og lagringsforsøg med byg. Landøkonomisk Forsøgslaboratoriums efterårsmøde, Arbog, 64-74 (1970), cold-rolled barley administered in dry state had lower feed utilizing efficiency than barley ground in a hammer mill. No differences were noted in broth feeding. In: Näsi, M., Effects of grinding, pelleting and expanding on nutritive value of barley in pig diets, Agric. Sci. Finl. 1: 461-469 (1992) the effects of hammer mill grinding, granulating and expander treatment on the nutrient digestibility of barley fed to pigs and on albumin utilization were compared. It may be mentioned regarding hammer mill grinding and rolling, that pigs which had been given rolled barley retained more nitrogen, according to the study, and albumin utilization was more efficient than in those which had been given hammer mill-ground barley. Furthermore, in: CAB Abstracts 0861579, ONO59-03252, Journal of Agricultural Association of China 1988, 144:76-84, and in: CAB Abstracts 0807082, ONO59-02386, Journal of the Agricultural Association of China 1987, 138:87-95, the influence of particle size of corn or durra comminuted

in a dry roll grinder on the digestibility of pig feed containing the respective cereal and on the growth of the animals has been considered.

5 With the aid of the present invention an entirely different problem has been solved, associated with digestibility of feed containing cereal meal and used in connection with power feeding of pigs, and on the digestive tract damage caused by such feed in pigs. The problem has been solved in that now, for the
10 first time ever, a comparison has been made of hammer mill grinding and dry roll grinding in the case of pig feed such as is nowadays used in power feeding, and the effect exerted by the particle structure of dry-rolled cereal on indigestibility of the cereal and on
15 occurrence of digestive tract damage has been investigated.

As taught by the invention, the grains of cereal to be admixed to pig feed, such as wheat and/or barley, are comminuted or ground with a dry roll
20 grinder so that coarse particles are obtained of which more than 50% have particle size 1-5 mm, advantageously 1-4 mm, and cumulative pore volume of the particles in the range from 0.01 to 10 μm is 0.08-0.2 cm^3/g , advantageously 0.09-0.15 cm^3/g . Of the particles that are
25 formed, e.g. more than 50% have particle size 1-4 mm, advantageously more than 60%, 1-3 mm. The mean particle size D_{Pm} of the comminuted cereal is suitably 1-4 mm, advantageously 1.5-2.5 mm.

Grinding is advantageously accomplished at
30 cereal moisture content less than about 15% and in the form of so-called cold rolling, that is, at a temperature below about 20°C or below about 25°C.

For roll grinder any dry roll grinder may be used which produces particles having the properties
35 mentioned above. The roll grinder is commonly known in feed producing technology and will not be described in any greater detail in this context.

As taught by the invention, the comminuted cereal is then possibly admixed and/or combined by granulation with other pig feed raw materials commonly used in order to produce pig feed for use in power feeding and, if required, processed further in a manner known in the art.

Cereal meal comminuted according to the invention can be used in feeds for any single-stomach production animal, e.g. pig, chicken etc. in replacement of presently used cereal fine-ground in a hammer mill, in order to reduce the digestive tract-damaging effect of the feed without impairing the digestibility of the feed.

The procedure of the invention is suited in particular for comminution of low-fat cereal, such as wheat, barley, corn etc., or in general any other low-fat cereal-like product, such as peas, etc.

The invention is described in the following with the aid of embodiment examples, referring to the attached drawings, wherein:-

Fig. 1 presents the cumulative pore volume in the range of 0.01 to 10 μm of hammer mill-ground conventional barley meal (FII = interfacial contact angle, $\emptyset$ = edge contact angle; DS = derivate scale factor),

Figs 2a-b present the cumulative pore volume in the range of 0.01 to 10 μm of the particles of barley granules ground according to the invention (FII = interfacial contact angle, $\emptyset$ = edge contact angle; DS = derivate scale factor), and

Fig. 3 presents the cumulative pore volume in the range of 0.01 to 10 μm of rifle-ground barley (FII = interfacial contact angle, $\emptyset$ = edge contact angle; DS = derivate scale factor).

The examples are only meant to illustrate the invention, without confining it in any way whatsoever.

Example 1: Particle distribution of barley for admix-

ture to pig feed

A roll grinder was employed in the grinding process. Roll diameter was 600 mm and length, 1250 mm.

Barley, with moisture content about 15%, and cold (e.g. with temperature equivalent to outdoor temperature), was comminuted in said roll grinder. Rolling capacity was 12 to 18 tons/hr.

Coarse barley meal was obtained, for which the following particle distribution was found using a wire screen with square apertures:

	<u>Particle size</u> (wire screen)	Proportion
	Over 4 mm	0 to 15% by weight
	1.6 to 4 mm	55 to 70% by weight
15	1 to 1.6 mm	15 to 25% by weight
	0.315 to 1 mm	5 to 15% by weight
	less than 0.315 mm	1 to 5% by weight

Thus, more than 85% by weight of the product had particle size over 1 mm, more than 75% by weight had particle size over 1.6 mm.

Example 2: Particle size of ground barley and pore volume

In this measurement, barley was ground as in Example 1, in equivalent conditions (fractions I and II). Coarse barley meal was obtained, for which the following particle distribution was measured, using a wire screen:

30	<u>Particle size</u> (wire screen)	I	II
	Less than 0.28 mm	3.0%	3.7%
	0.28 to 0.5 mm	2.7%	2.3%
	0.5 to 1.0 mm	13.6%	11.2%
	1.0 to 1.4 mm	18.5%	16.5%
35	1.4 to 2.0 mm	26.4%	24.6%
	2.0 to 2.8 mm	21.8%	25.0%
	Over 2.8 mm	14.0%	16.7%

Mean particle size (DPm) was found by measurement to be 1.5 to 2.5 mm, more than 60% of particles were within 1 to 3 mm.

5 For the ground particles the cumulative pore volume was measured in the interval from 0.01 to 10 μ m (measured by mercury porosimeter); it was 0.10 to 0.11 cm^3/g ; Fig. 1, and likewise that of rifle-ground barley, DPm 2.1 mm, cumulative pore volume 0.075 cm^3/g . The results of measurement were graphically plotted in
10 detail; Fig. 1: hammer mill-ground barley, DPm 0.65 mm; Figs 2a-b: barley ground according to invention DPm 1.7 to 2.0 mm, fractions I and II; and Fig. 3: rifle-ground barley DPm about 2.1 mm. In the figures the cumulative pore volume (in cm^3/g) is plotted over
15 pore volume for the interval from 0.01 to 10 μ m.

Example 3: Production test

In the test, cereal meal according to Examples 1 and 2 was used in the form of cereal meal conforming to the invention (R or ROLL). For reference
20 meal, hammer mill-ground cereal meal (HM) representing the state of art was used.

Table 1 shows the results that were obtained. The table reveals that incremental growth and feed
25 utilization of the pigs in the case of pigs given dry-rolled feed according to the invention equalled or surpassed those of the pigs given hammer mill-ground meal.

The stomachs were examined and graded according to a classification which was developed. In the
30 tests only 1 to 7% of the stomachs of pigs fed hammer mill-ground cereal were classified as normal, while 11 to 18% of the pigs displayed severe changes. In the group of pigs given cereal according to the invention,
35 40 to 67% of the stomachs were normal, and there were no severe changes at all.

TABLE 1

A. PRODUCTION TESTS

		TEST 1		TEST 2		TEST 3	
5		HM	ROLL	HM	R	HM	ROLL
	Number of pigs	64	32	32	32	80	80
10	Incremental growth, g per day	816	864	898	921	891	901
	Feed, kg per kg	2.88	2.72	2.64	2.59	2.65	2.63
	Growing days	96	93	90	90	86	85
15	Normal stomach, in % of the pigs	4.8	61.3	7.1	66.7	1.3	40.0
20	Severe changes, in % of the pigs	17.6	0	10.8	0	16.3	0

CLAIMS

1. A procedure for comminuting grains of cereal to be admixed to the feed of a single-stomach production animal. in particular a pig, characterized in that the cereal grains are ground in a dry roll grinder into coarse-divided particles so that more than 50% of the comminuted cereal has particle size 1 to 5 mm and the cumulated pore volume of the particles in the range from 0.01 to 10 μm is 0.08 to 0.2 cm^3/g , advantageously 0.09 to 0.15 cm^3/g , so that with the cereal meal is achieved reduced effect damaging the digestive tract without incurring its impaired digestibility.
2. Procedure according to claim 1, characterized in that the cereal grains are comminuted so that more than 50% by weight of the comminuted cereal has particle size 1 to 4 mm, advantageously over 60% has particle size 1 to 3 mm.
3. Procedure according to claim 1 or 2, characterized in that the cereal grains are comminuted so that mean particle size D_{Pm} of the comminuted cereal will be 1 to 4, advantageously 1.5 to 2.5 mm.
4. Procedure according to any one of claims 1-3, characterized in that for cereal to be comminuted is used wheat, barley and/or corn.
5. Procedure according to any one of claims 1-4, characterized in that comminution is carried out as a cold rolling process.
6. Procedure according to any one of claims 1-5, characterized in that comminution is carried out at moisture content of the cereal less than about 15%.
7. Pig feed containing comminuted cereal, characterized in that the cereal has been comminuted in a dry roll grinder in order to obtain coarse particles of which more than 50% by weight have particle size 1 to 5 mm, advantageously 1 to 4 mm, most advan-

tageously more than 60% have particle size 1 to 3 mm, and cumulative pore volume of particles in the range from 0.01 to 10 μm is 0.08 to 0.2 cm^3/g , advantageously 0.09 to 0.15 cm^3/g , so that the pig feed has reduced effect damaging the digestive tract, without impairment of its digestibility.

8. Pig feed according to claim 7, characterized in that the cereal product is wheat, barley and/or corn.

9. A procedure for reducing the effect damaging the digestive tract of pig feed containing ground cereal without impairing the digestibility of the feed, characterized in that in the pig feed is used cereal comminuted in a dry roll grinder for obtaining particles of which more than 50% by weight have particle size 1 to 4 mm, preferably more than 60% by weight have particle size 1 to 3 mm, and the cumulative pore volume of particles in the range from 0.01 to 10 μm is 0.08 to 0.2 cm^3/g , advantageously 0.09 to 0.15 cm^3/g .

10. Procedure according to claim 9, characterized in that in the pig feed is used wheat, barley and/or corn.

ABSTRACT OF DISCLOSURE

5 The invention concerns a procedure for comminuting the grains of cereal to be admixed to the feed of a single-stomach production animal, in particular a pig, the cereal grains being comminuted in a dry roll grinder into coarse particles so that more than 50% by weight of the comminuted cereal has particle size 1 to 5 mm and the cumulative pore volume of the particles in the range from 0.01 to 10 μm is 0.08 to 0.2 cm^3/g , so that with the cereal meal is achieved reduced effect damaging the digestive tract without incurring its impaired digestibility.

10 The invention further concerns comminuted pig feed in which the cereal meal has been comminuted in a dry roll grinder for obtaining coarse particles of which more than 50% by weight have particle size 1 to 5 mm, and the cumulative pore volume of particles in the range from 0.01 to 10 μm is 0.08 to 0.2 cm^3/g .

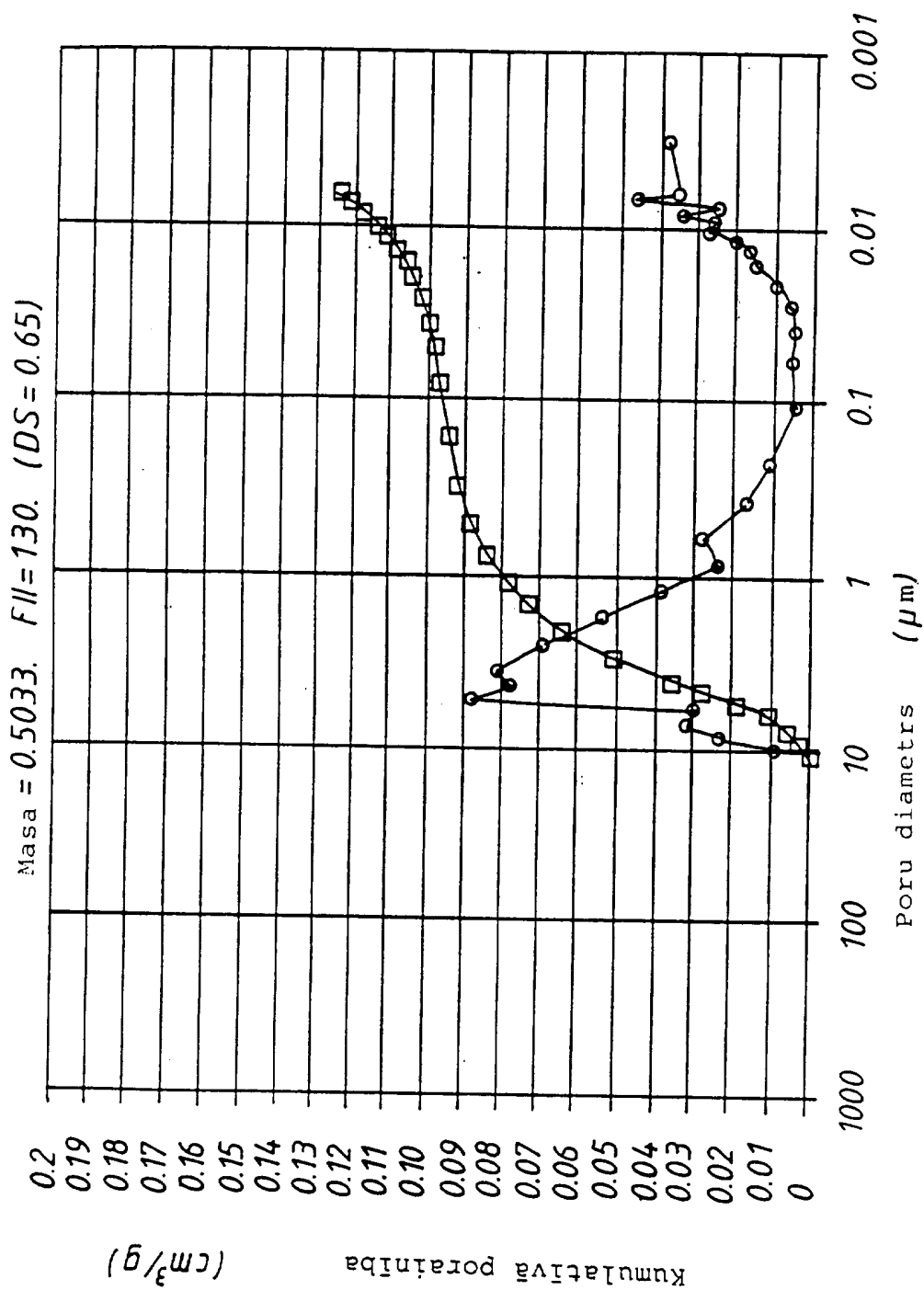


Fig.1

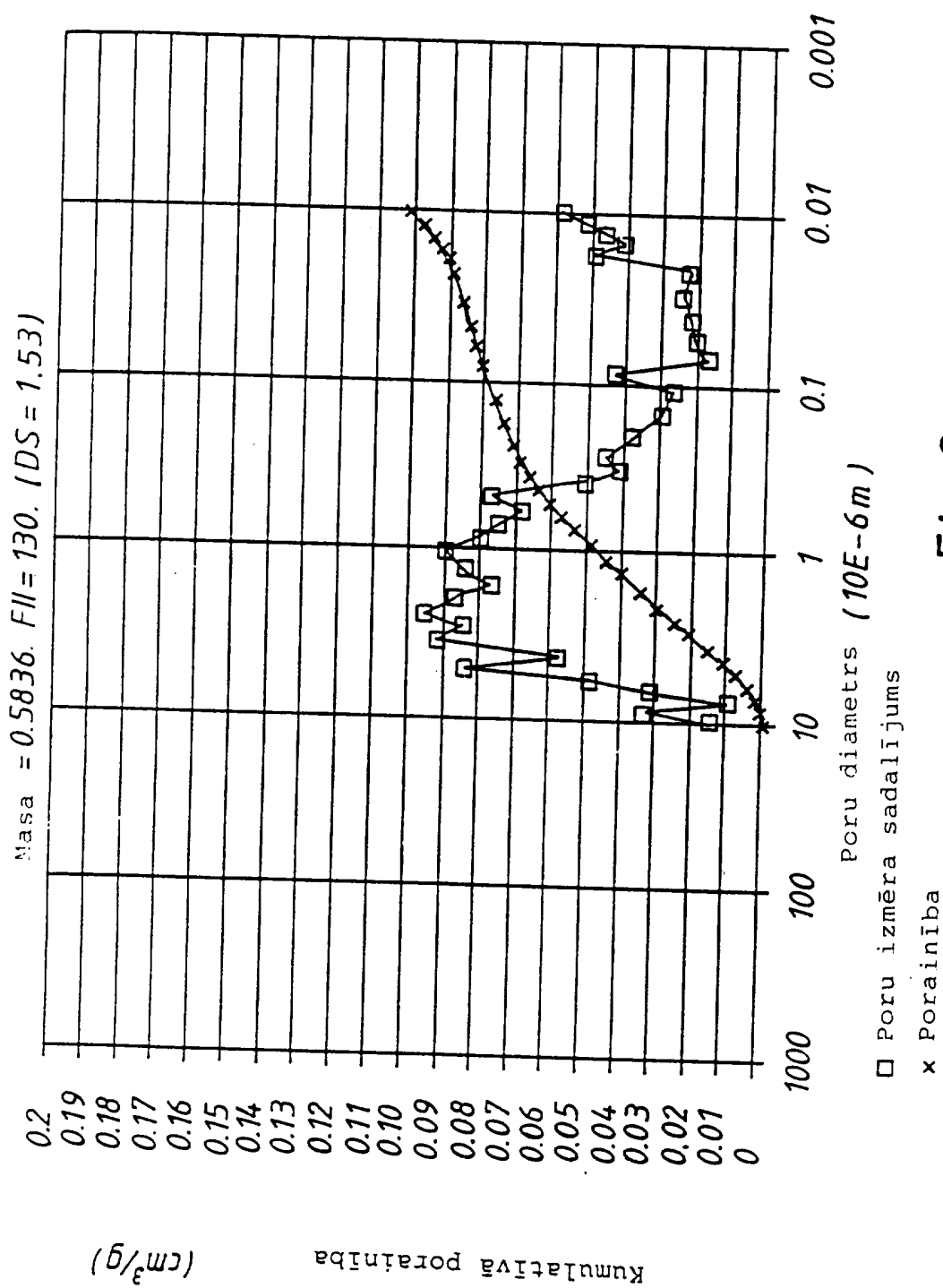


Fig. 2a

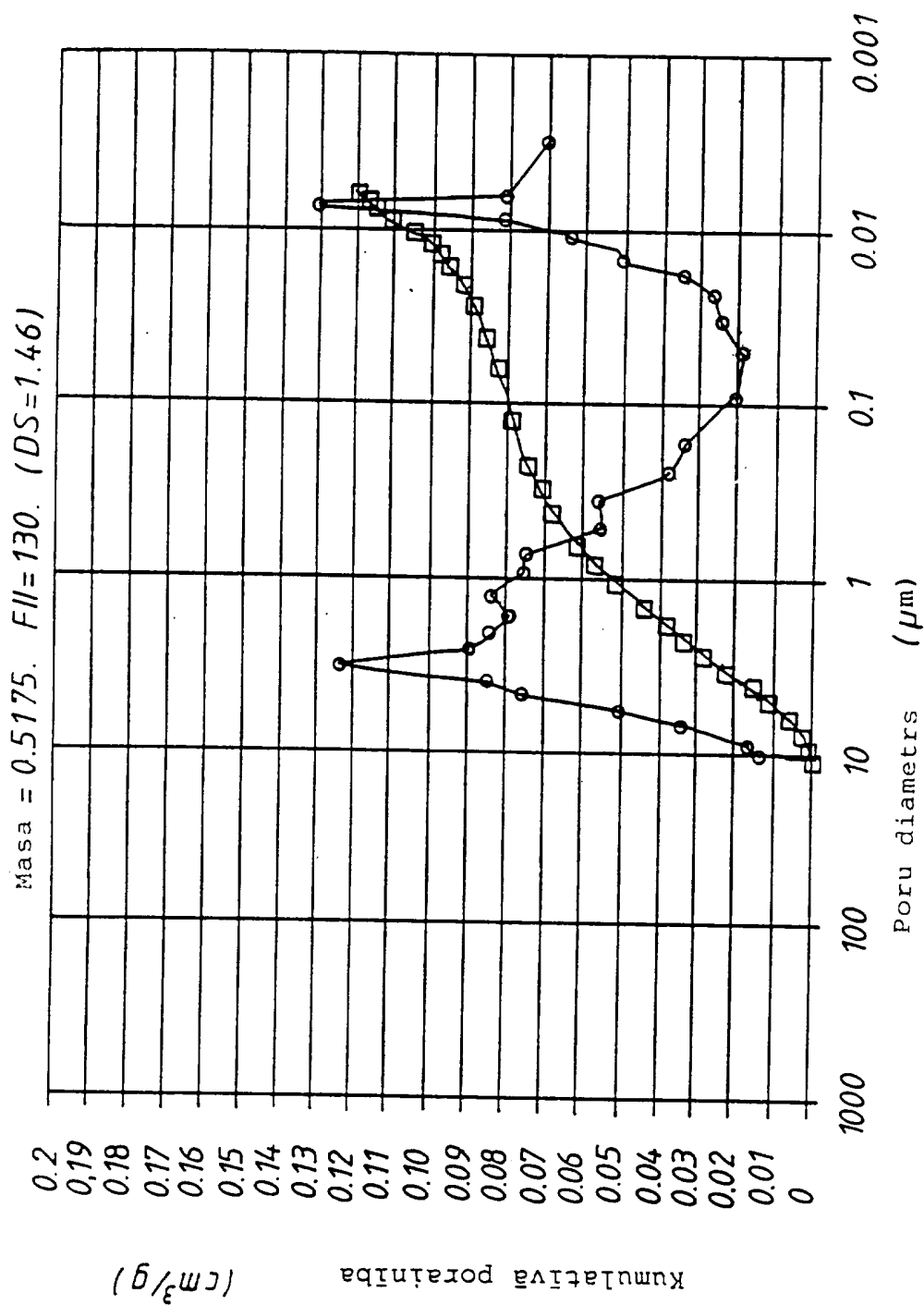


Fig. 2b

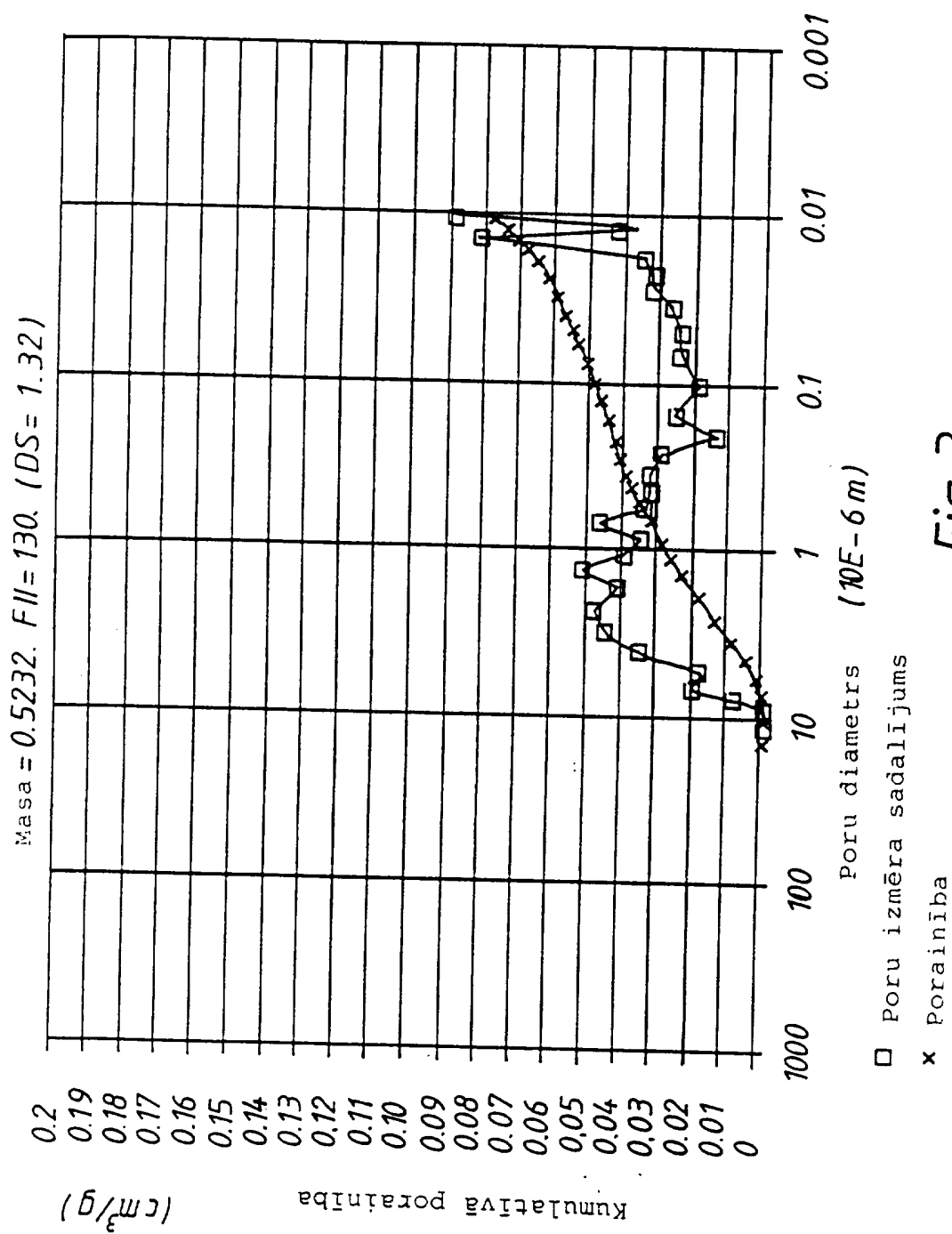


Fig. 3