The Influence of Hammer Type Used in Grinding Mills on Grist Fineness

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Abstract. Hammer mills are machines used in agriculture graded to obtain concentrated fodder mix and food industry for grinding vegetable raw materials necessary for obtaining various types of flours. The hammer mills grinding materials is produced upon impact of the hammer material and crushing plate located inside the grinding chamber.

Depending on the hammers rotor assembly mode, the following types of mills can be used: hammer mills articulated and fixed hammer mills.

The objective of this paper is to study the influence of hammer profile during the operation of grinding wheat on hammer mills using the same sieve.

Keywords: agricultural, food, mills, grinding, hammer

INTRODUCTION

A research team from Technical Science and Soil Science Department of USAMV Cluj-Napoca, has carried during several years, studies of few agricultural machines made by several companies. Of these may be mentioned: rotary mowers, rotary rakes, spraying machines, feed mixers and hammer mills.

Grinding is the operation to reduce the geometrical dimensions of the particles by destroying their physical integrity, as a result of mechanical action on the material. Applications in the food industry are reflected in most branches of the food industry: milling, sugar refinery, canned food, starch, alcohol, beer, wine, etc.

Grinding operation efficiency consists in the conversion with minimum power consumption and maximum productivity gave one solid material in a powdery or granular product size and shape required. Achieving this goal depends on a variety of factors:

- humidity is usually a negative factor with adverse effects on the process of crumbling;
- fineness of the material to be cut decreases productivity and increases the consumption of energy, so the cost of operation;
- the degree of crumbling (m) depends on the type of machine and the size of the pieces obtained:

$$m = \frac{d_1}{d_2}, \quad (1)$$

Where: d_1 - size of the original material; d_2 - product size.

For large pieces the degree of crumbling m take values from 2 to 25, and to decrease the size of grinding can be reached at $m = 150$ (crumbling in several stages).

The aim of this paper is to study the influence of moisture during the operation of grinding wheat on hammer mills using the same sieve.

MATERIALS AND METHODS

To experience used a hammer mill type MB 7.5 (7,5 kW - electric engine power, productivity 0,7 tonne/hour). Material used to experience was a variety of wheat named *Ariesan* with two different humidity: 14% and 18%. The mill we used two types of hammers, three different types of sieve used on mill (4-6-8 mm). Sieving (sifting) is a mechanical operation realized trough separation in granulometric factions of some polidisperse mixtures of granules and powder on the basis of particle shape and size. For sifting was used a sieving machine AS 300 (Fig. 3). The grist result was separated using 4 types of sieve and 1 collector resulting 5 types of grist. From each sample was used a quantity of 500 g wheat.

For each determination using 3 samples at the same hammer, the same sieve and the

Fig.1. Hammers mill, sieve and hammers used on experiment

Fig. 2. The plant used for determination

Fig. 3. Sieving machine AS 300

same moisture content resulting 36 values. Have been used the following notation: c1 - hummer type 1; c2 - hummer type 2; Mill sieve mesh size are marked with the letter M with the following characteristics: M1 – 4 mm diameter, M2 – 6 mm diameter and M3 – 8 mm diameter; g1 humidity 1= 14%, g2 humidity = 18%. Sifting sieves are notated with: s1 – 2.5 mm, s2 – 1.25 mm, s3 – 0.63 mm and s4 – 0.25 mm diameter holes. Sieving machine working mode was set for each sample in part to be continuously 2 minutes with amplitude of vibration of 1.0 mm/g.

RESULTS AND DISCUSSIONS

The grist result was classified using a four-site sieving machine with hole diameters between 2.5 mm and 0.25 mm. Tab. 1 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M1 at the g1 moisture and milling analysis obtained by sieving machine.

Tab. 1

The comparative results obtained using sieve M1 for g1 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M1g1	6	196	138	11	146	497
c1M1g1	14	176	131	13	164	498
c1M1g1	16	158	124	16	183	497
Total	36	530	393	40	493	1492
c2M1g1	1	150	192	14	139	496
c2M1g1	2	135	182	17	161	497
c2M1g1	4	121	172	21	180	498
Total	7	406	546	52	480	1491

Tab. 2 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M1 at the moisture g2 and milling analysis obtained by sieving machine.

Tab.2

The comparative results obtained using sieve M1 for g2 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M1g2	10	260	134	11	81	496
c1M1g2	12	234	127	13	111	497
c1M1g2	14	210	120	16	138	498
Total	36	704	381	40	330	1491
c2M1g2	6	183	166	11	131	497
c2M1g2	14	164	157	13	150	498
c2M1g2	16	147	149	16	169	497
Total	36	494	472	40	450	1492

When using the first type of hammer c1, mill sieve M1 and g1 moisture compared with the second type of hammer c2 under the same conditions (Tab. 1) is obtained a greater amount of grist on the sieves s1, s2 (with dimensions larger holes) and collector but a smaller amount of grist on sieve S3 and S4. When humidity increases to the value g2 (Tab. 2) amount of grist in the sieve s2 increases in both cases using hammer c2 increases fine grist collector.

Tab. 3 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M2 at the moisture g1 and milling analysis obtained by sieving machine.

Tab. 3

The comparative results obtained using sieve M2 for g1 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M2g1	8	235	153	13	88	497
c1M2g1	14	211	145	16	112	498
c1M2g1	16	189	137	20	135	497
Total	38	635	435	49	335	1492
c2M2g1	11	273	131	8	73	496
c2M2g1	13	245	124	10	105	497
c2M2g1	15	220	117	12	134	498
Total	39	738	372	30	312	1491

Tab. 4 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M2 at the moisture g2 and milling analysis obtained by sieving machine.

Tab. 4

The comparative results obtained using sieve M2 for g2 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M2g2	16	274	120	8	80	498
c1M2g2	19	246	114	10	108	497
c1M2g2	22	221	108	12	135	498
Total	57	741	342	30	323	1493
c2M2g2	14	244	133	9	98	498
c2M2g2	16	219	126	11	125	497
c2M2g2	19	197	119	13	150	498
Total	49	660	378	33	373	1493

When using the second type of hammer c2, mill sieve M2 and g1 moisture compared with the first type of hammer c1 under the same conditions (Tab. 3) is obtained a greater amount of grist on the sieves s1, s2 (with dimensions larger holes) and a smaller amount of grist on sieve S3, S4 and collector. When humidity increases to the value g2 (Tab. 4) amount of grist in the sieve s1 and s2 increases using hammer c2 increases fine grist in s3, s4 and collector.

Tab. 5 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M3 at the moisture g1 and milling analysis obtained by sieving machine.

Tab. 5

The comparative results obtained using sieve M3 for g1 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M3g1	18	292	111	8	69	498
c1M3g1	21	262	105	10	99	497
c1M3g1	25	235	99	12	127	498
Total	64	789	315	30	295	1493
c2M3g1	15	266	132	10	75	498
c2M3g1	18	239	125	12	103	497
c2M3g1	21	215	118	15	129	498
Total	54	720	375	37	307	1493

Tab. 6 shows the comparative results obtained using two types of hammers for grinding wheat with mill sieve M2 at the moisture g2 and milling analysis obtained by sieving machine.

Tab. 6

The comparative results obtained using sieve M2 for g2 moisture of wheat

Code	s1 [g]	s2 [g]	s3 [g]	s4 [g]	collector [g]	total [g]
c1M3g2	43	316	87	5	47	498
c1M3g2	51	284	82	6	74	497
c1M3g2	61	255	77	7	98	498
Total	155	855	246	18	219	1493
c2M3g2	44	324	83	3	45	499
c2M3g2	52	291	78	3	74	498
c2M3g2	62	261	74	3	97	497
Total	158	876	235	9	216	1494

When using sieve M3 (double size M1) and hammer c1 at g1 moisture (Tab. 5) the grist from the sieve s1 and s2 is greater than c2 hammer used. On the sieve s3, s4 and

collector when using C2 hammer to get more grist than with c1 hammer. When humidity increases to the value g2 (Tab. 6), hammer c2, the sieve s1 and s2 is greater than c1 hammer used in the same condition and decrease the value from c3 and c4 sieve.

CONCLUSION

Influence the type of hammer mill and the grist sieve obtained can be interpreted analysing experimental values presented in Tab. 1 to 6. The moisture of wheat variety is very important for the quality and quantity of grist be influenced by the type of hammer used. Thus, for hammer type 1 greater amount of grist was obtained on the site s1, s2 and s3 and s4 Site and the second type of collector hammers. Grinding higher moisture grain with g2 was obtained on sieve s2 a larger amount of grist for the mill sieve M. A lower moisture content g1 getting the collector caused a greater amounts of grist. In order to get a certain type of fineness of milling, material moisture must be chosen depending on the degree of grinding required.

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