The outer quality loss during grain post-harvest treatment and handling

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ABSTRACT: In the paper are presented results of grain outer quality loss investigation during its post-harvest treatment. Objective was to determine the grain damage during its transport by bucket elevators of type "SANFON" at bucket peripheral velocity 2.0 m/s and 2.8 m/s of capacity 40 t/h and 80 t/h, respectively. The damage was investigated at counter-flow and parallel-flow bucket filling. From the measured results resulted the conclusion, that the bucket elevators tend rather to grain crushing, i.e. fraction creation than to smaller damage. On basis of partial knowledge chain elevators have no significant tendency to fraction generation, but incline considerably to the transported grain total mechanical damage at performance significantly lower than is the nominal one. In that case total mechanical damage ranged from 1.78 to 1.98%. Auger conveyers tend rather to total mechanical damage of transported grain than to the fraction creation. This is caused mainly by the friction between the transported grain and transporting "trough". Total mechanical damage is in range from 1.36 to 1.73%. Belt elevators are friendly to transported grain and therefore are evitable for grain horizontal transport in lines for reception, treatment and storage of food grain crops.

Keywords: outer quality; bucket elevator; chain elevator; auger elevator; belt elevator; fraction; total mechanical damage; grain

The grain crop quality is a complex of indicators expressing applied parameters of grain type according to the next use purpose. There exists outer and inner quality.

The outer quality is represented by material physical-mechanical properties, e.g. admixtures and impurities, granulometric mixtures (expressed as share on sieve of certain size), volume weight (expressed in hectolitre weight value), weight of 1,000 grains, sample small, pests presence or their larvae etc.

The inner quality is represented by qualitative indicators given by material biochemical properties being applied always for planned purpose of given grain crop utilization. The qualitative indicators are expressed by pertinent measurable indicators and associated into business relationships. As food wheat concerns it is mainly gluten content, N-matters content, decrease number, SDS-test value, for seed stock it is particularly germination and germinative energy.

Section of reception, cleaning and handling within the post harvest systems is in correlation grain outer quality, i.e. cleaning and mainly mechanical damage. Handling grain generally is a source of large mechanical damage. This work objective is to determine grain mechanical damage during bucket elevator transportation, chain elevator, auger and belt elevators which are the most extended in the post-harvest systems of the Czech agriculture.

METHOD

The most considerable transport share in the existing post-harvest lines provide belt, chain and bucket elevators. The belt elevators are the most friendly principle for grain horizontal transport (KROUPA 2001). The bucket elevators represent relative high risk of transported grain mechanical damage. The auger elevators are source of damage mainly for malt barley (broken germs). It concerns mainly the auger conveyers with closed trough (KROUPA 2002; FAMĚRA 2001). In existing lines are fortunately used minimally – but recently they have been introduced to simple lines. In high-performance lines are being used the chain elevators. Under load the grain damage is acceptable, but in "idle" operation the damage rate is high.

Sampling methodological process

For every test the samples were taken before their entry into relevant elevator and always three samples after grain passing through. Particular samples were taken in small partial amounts within 2–3 minutes in such manner, that whole sample weight was about 2–3 kg. 15 minutes break was inserted between particular samples taking-off.

The sampling began during the tested elevator filling and continued by samples taking-off during grain discharge from the tested elevator after the passing of time resulting from peripheral velocity and transporting distance of elevator.

In each sample was determined the transported grain moisture before its entry into the tested elevator. From every sample two batches (100 g each) were taken after thorough blending. Each batch was processed separately.

Results presented in this paper were acquired within Research Project No. 1201 of the Ministry of Agriculture of the Czech Republic.

The batch was classified into fractions, other mechanically damaged grain, non-damaged grain and impurities including admixtures. The fractions were considered the parts smaller than one half. Mechanically damaged grain, other damages, i.e. parts bigger than one half of grain, pressed grains with visible cracks or scratches were included among other than factors. Among impurities were incorporated the weed seeds, parts of straw and of weeds, mineral admixtures, seeds of other cereals.

The undamaged grain, fractions and other mechanically damaged grain was weighed. The undamaged grain, fractions and other mechanically damaged grain total weight is considered the basis for fractions and other damage grain amount per cent expression.

The sampling was carried out in compliance with the Standards ČSN ISO 950, qualitative requirements for food grain are presented in the following Standards: ČSN 46 1100–2 Wheat, ČSN 46 1100–5 Malt barley.

RESULTS

Bucket elevators

The aim was to determine the grain damage during the bucket elevator transportation with steel buckets and those of "SANFON" type at peripheral velocity 2.0 m/s and 2.8 m/s of performance class 80 t/h and 40 t/h which are the most used in existing post-harvest lines in agricultural primary production.

Basic technical parameters:

- bucket elevator output 75 t/h
- transport height 24 m
- bucket volume 0.77 dm^3
- bucket pitch 200 mm
- bucket width 155 mm
- type of bucket "STANDARD"
- peripheral velocity of bucket 2.0 m/s

Table 1. Grain damage – steel buckets "STANDARD", output 63 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before elevator	behind elevator	increase caused by elevator	before elevator	behind elevator	increase caused by elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Food wheat Brea	764	15.60	0.90	1.43	0.53	2.10	2.56	0.46
				0.89	1.51	0.62	1.61	2.00	0.39
2	Brea	760	15.10	1.00	1.48	0.48	1.83	2.16	0.33
				1.03	1.58	0.55	1.71	2.12	0.41
3	Brea	751	14.60	0.97	1.66	0.69	1.88	2.21	0.33
				1.02	1.73	0.71	1.69	2.08	0.39
Total average			15.10	0.96	1.56	0.59	1.80	2.18	0.38

To Table 1 belongs graph in Fig. 1

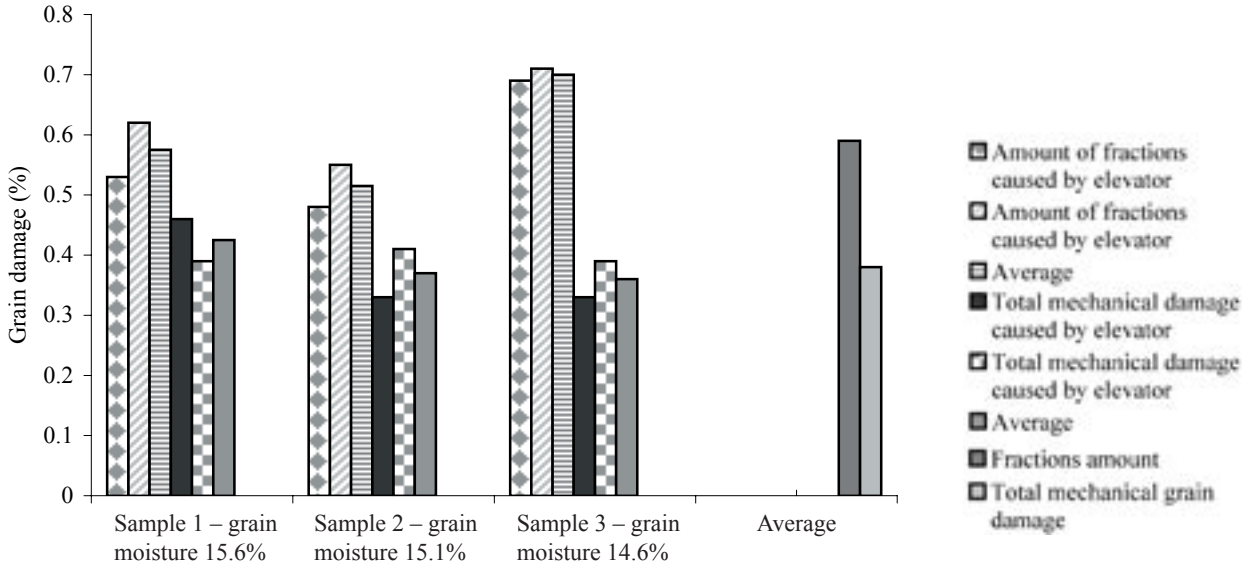

Fig. 1. Grain damage by bucket elevator, type "STANDARD", performance 63/h, bucket filling: counter-flow, food wheat Brea

– bucket filling	counter-flow	– bucket width	220 mm
– installed output	7.5 kW.	– type of bucket "SANFON"	7 buckets without bottom and 1 with bottom
Basic technical parameters:			
– bucket elevator output	80 t/h		
– transport height	23 m	– peripheral velocity of bucket	2.8 m/s
– bucket volume	1.16 dm^3	– bucket filling	counter-flow
– bucket pitch	64 mm	– installed output	7.5 kW.

Table 2. Grain damage – steel buckets "SANFON", output 68 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before elevator	behind elevator	increase caused by elevator	before elevator	behind elevator	increase caused by elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Food wheat Brea	794	13.60	0.66	1.14	0.48	1.76	2.09	0.33
				0.71	1.03	0.32	1.91	2.36	0.45
2	Brea	790	13.10	0.83	1.52	0.69	2.12	2.51	0.39
				0.75	1.31	0.56	1.09	1.35	0.26
3	Brea	791	13.30	0.69	1.10	0.41	1.82	2.11	0.29
				0.77	1.39	0.62	1.93	2.30	0.37
Total average			13.33	0.73	1.24	0.51	1.77	2.12	0.34

To Table 2 belongs graph in Fig. 2

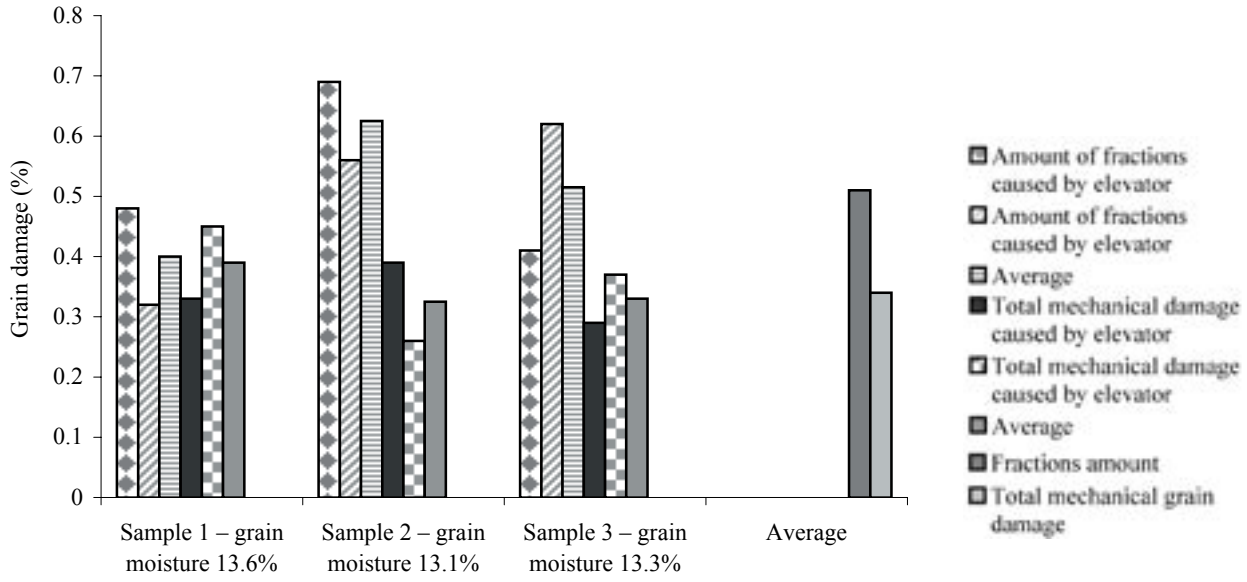

Fig. 2. Grain damage by bucket elevator, type "SANFON", performance 68 t/h, bucket filling: counter-flow, food wheat Hana

Basic technical parameters:

- bucket elevator output 40 t/h
- transport height 15 m
- bucket volume 1.04 dm^3
- bucket pitch 200 mm
- bucket width 180 mm
- type of bucket "STANDARD"
- peripheral velocity of bucket 2.0 m/s
- bucket filling counter-flow
- installed output 4 kW.

Table 3. Grain damage – steel buckets "STANDARD", output 328 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before elevator	behind elevator	increase caused by elevator	before elevator	behind elevator	increase caused by elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Food wheat Brea	771	14.60	0.52	1.23	0.71	1.93	2.15	0.22
				0.64	1.29	0.65	1.90	2.21	0.31
2	Brea	770	14.40	0.72	1.31	0.59	2.35	2.54	0.19
				0.83	1.46	0.63	2.16	2.45	0.29
3	Brea	783	14.60	0.74	1.25	0.51	2.13	2.38	0.25
				0.75	1.30	0.55	2.23	2.46	0.23
Total average			14.53	0.70	1.30	0.61	2.11	2.36	0.24

To Table 3 belongs graph in Fig. 3

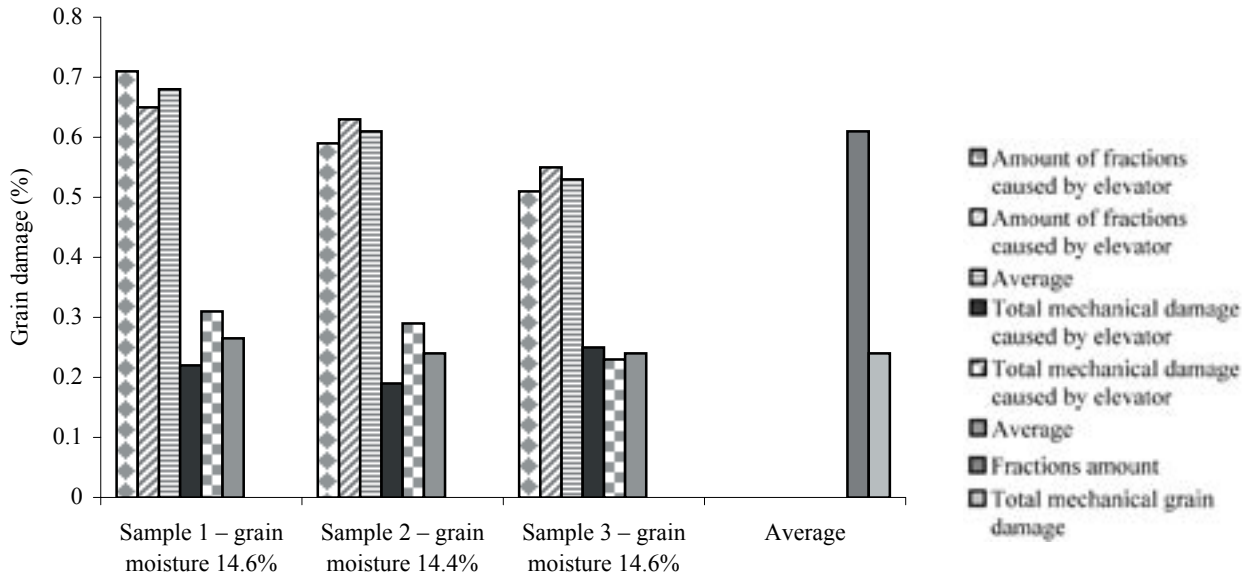

Fig. 3. Grain damage by bucket elevator, type "STANDARD", performance 32 t/h, bucket filling: counter-flow, food wheat Ebi

Basic technical parameters:

- bucket elevator output 40 t/h
- transport height 15 m
- bucket volume 1.04 dm^3
- bucket pitch 200 mm
- bucket width 180 mm
- type of bucket "STANDARD"
- peripheral velocity of bucket 2.0 m/s
- bucket filling parallel-flow
- installed output 4 kW.

Table 4. Grain damage – steel buckets "STANDARD", output 30 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before elevator	behind elevator	increase caused by elevator	before elevator	behind elevator	increase caused by elevator
		(g/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Food wheat Brea	765	14.80	0.67	1.41	0.74	1.78	2.23	0.45
				0.83	1.49	0.66	2.19	2.68	0.49
2	Brea	760	14.60	0.59	1.39	0.79	2.14	2.55	0.41
				0.61	1.46	0.85	1.56	2.14	0.58
3	Brea	768	14.50	0.65	1.44	0.79	2.14	2.53	0.39
				0.63	1.26	0.63	1.85	2.31	0.46
Total average			14.60	0.66	1.40	0.74	1.94	2.40	0.46

To Table 4 belongs graph in Fig. 4

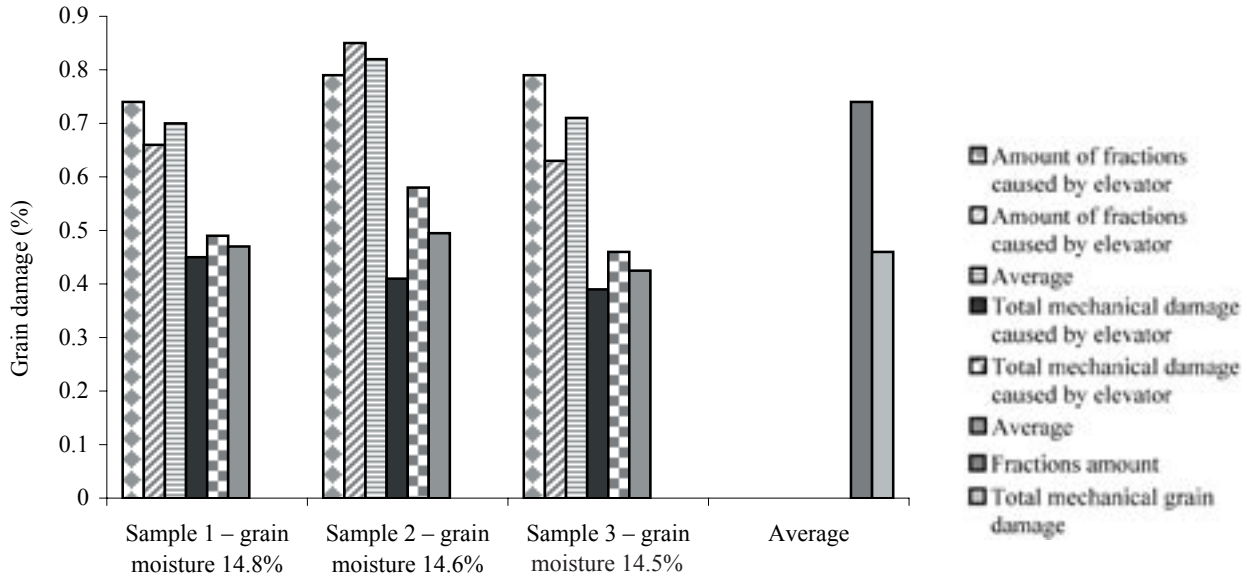

Fig. 4. Grain damage by bucket elevator, type "STANDARD", performance 30 t/h, bucket filling: counter-flow, food wheat Ebi

Evaluation of the summarized knowledge gives the following conclusions:

Performance class 80 t/h:

- For the bucket elevator type "SANFON" (7 buckets without bottom and 1 bucket with bottom) the fractions amount ranged from 0.32 to 0.69%. Total mechanical damage ranged from 0.26 % to 0.45%. The transported material was food wheat Hana of average moisture 13.33% and volume weight 790–794 kg/m^3.
- For the bucket elevator fitted by the buckets of type "STANDARD" (i.e. buckets with bottom) the fractions amount ranged from 0.48 to 0.71% and total mechanical damage ranged from 0.33 to 0.46%. The transported material was food wheat Brea of average moisture 15.1% and volume weight 751–764 kg/m^3. For both verified bucket elevators of the performance class 75–80 t/h the bucket filling was counter-flow.

Performance class 40 t/h:

– For the bucket elevator fitted by the buckets "STANDARD" (i.e. again buckets with bottom) the fraction amount has ranged from 0.51 to 0.71% and total mechanical damage ranged from 0.19 to 0.31%. The transported material was food wheat Ebi of average moisture 14.53% and volume weight 770–783 kg/m^3. The buckets filling was counter-flow.
– For the identical bucket elevator the investigation was carried out at parallel-flow buckets filling. The fraction amount ranged from 0.63 to 0.85% and total mechanical damage ranged from 0.39 to 0.58%. The transported material again was food wheat Ebi of average moisture 14.6% and volume weight 760 to 768 kg/m^3.

After the analysis of measured results it can be stated that the bucket elevators tend rather to the grain crushing, i.e. fractions creation than to the smaller damage. The lowest level of damaged grain has shown the bucket elevator "SANFON", effect of the performance class 80 (40) t/h on the base of partial results was not proved.

The chain elevators – redlers

The aim was to find the grain damage during transport by the chain elevator (redler) of nominal performance 32 t/h and transport distance 35 m and 25 m.

Basic technical parameters:

– chain elevator performance 32 t/h
– transport distance 35 m
– inner width of transport trough 250 mm
– chain links pitch 150 mm
– transport chain velocity 0.5 m/s
– type "STANDARD"
– buckets peripheral velocity 2,000 mm
– bucket filling parallel-flow
– installed output 7.5 kW.

Table 5. Grain damage – chain elevator "STANDARD" – horizontal transport, output 28 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before redler	behind redler	increase caused by redler	before redler	behind redler	increase caused by redler
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Alana	783	14.30	0.21	0.33	0.12	0.63	0.94	0.31
				0.28	0.38	0.10	0.72	0.95	0.23
2	Alana	780	14.10	0.26	0.39	0.13	0.68	0.94	0.26
				0.30	0.40	0.10	0.70	0.98	0.28
3	Alana	780	14.10	0.29	0.38	0.09	0.63	0.87	0.24
				0.23	0.34	0.11	0.75	1.01	0.26
Total average			14.16	0.26	0.37	0.11	0.68	0.95	0.26

To Table 5 belongs graph in Fig. 5

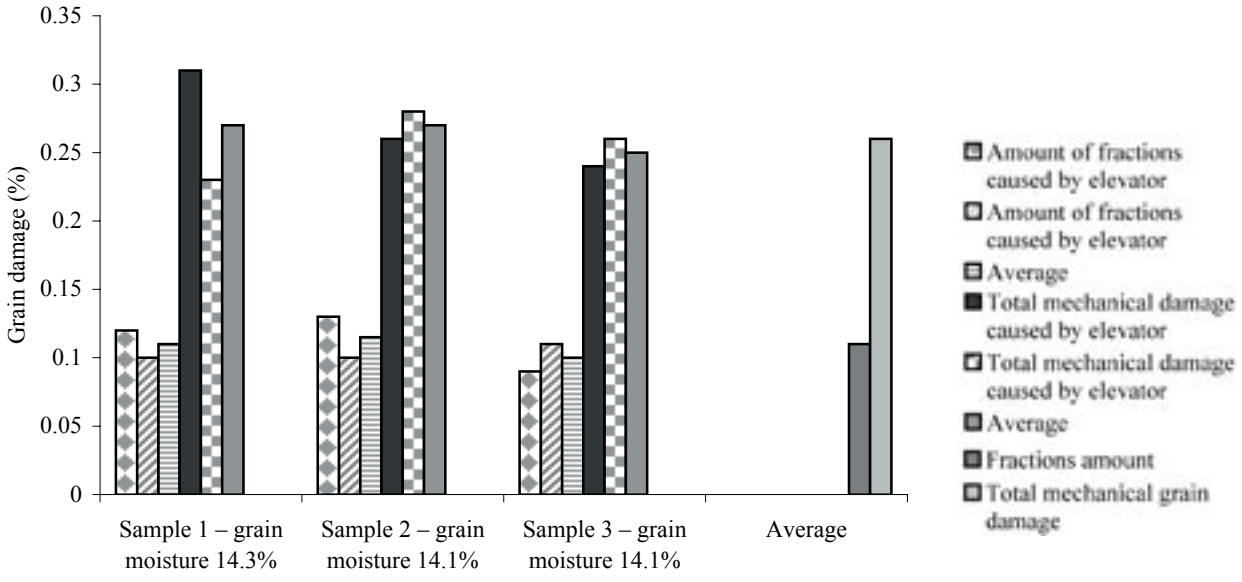

Fig. 5. Grain damage by chain elevator (redler), type "STANDARD", performance 28 t/h, food wheat Alana

Table 6. Grain damage – chain elevator "STANDARD" – horizontal transport, output 10.6 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before redler	behind redler	increase caused by redler	before redler	behind redler	increase caused by redler
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Alana	780	14.10	0.26	0.40	0.14	0.53	2.34	1.81
				0.21	0.37	0.16	0.58	2.36	1.78
2	Alana	780	14.20	0.23	0.35	0.12	0.64	2.55	1.91
				0.28	0.43	0.15	0.63	2.52	1.89
3	Alana	781	14.10	0.23	0.35	0.12	0.75	2.71	1.96
				0.21	0.33	0.12	0.70	2.68	1.98
Total average			14.10	0.24	0.37	0.13	0.64	2.53	1.88

To Table 6 belongs graph in Fig. 6

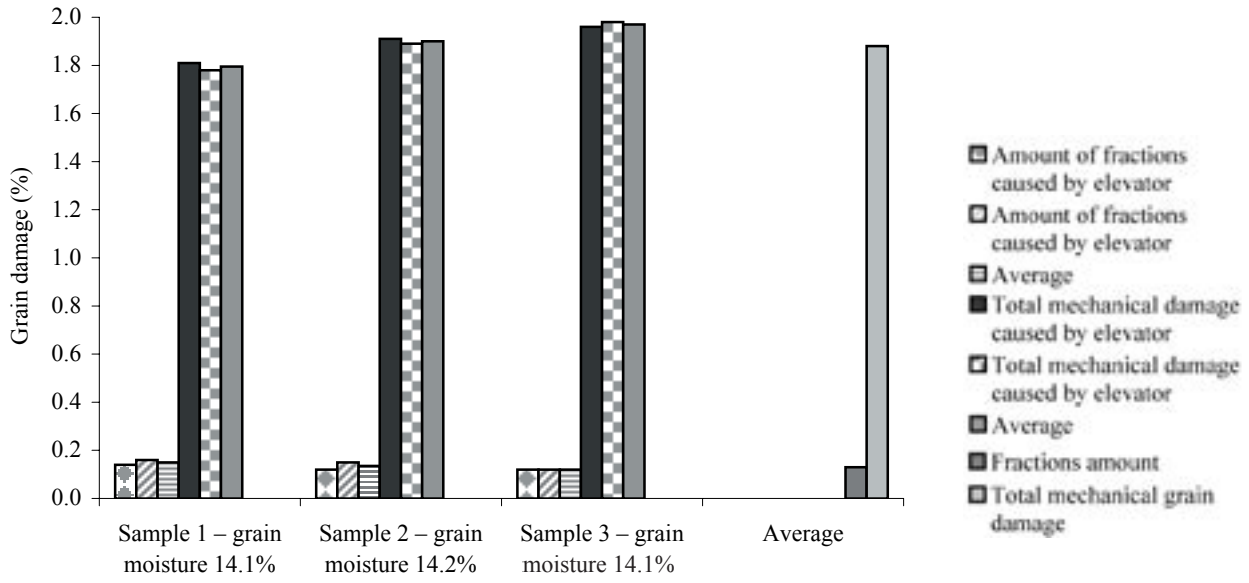

Fig. 6. Grain damage by chain elevator (redler), type "STANDARD", performance 10.6 t/h, food wheat Alana

After evaluation of the summarized partial knowledge it can be stated:

– For the chain elevator with grain horizontal transport and transport distance 35 m the fraction amount ranged from 0.09 to 0.13%. Total mechanical damage ranged from 0.23 to 0.31%. The transported material was food wheat Alana of average moisture 14.16% and volume weight 780–783 kg/m^3. Performance of that chain elevator is 28 t/h.
– For an identical type of the chain elevator with grain horizontal transport and transport distance 25 m, but with performance 10.6 t/h the fraction amount ranged from 0.12 to 0.16%. Total mechanical damage ranged from 1.78 to 1.98%. The transported material was food wheat Alana of average moisture 14.1% and volume weight 780–781 kg/m^3.
– From the measured values resulted the conclusion, that the chain elevators (redlers) do not tend significantly to the fraction creation but to total mechanical damage of transported grain, mainly at performance considerably lower than is nominal (see Table 6).

The auger conveyers

The aim was to determine the grain damage during transport by auger conveyers of screw diameter 200 mm and 320 mm. The verification was carried out for the auger conveyers with closed trough of performance class

12 t/h and 32 t/h which are the most used in the existing post-harvest lines.

Basic technical parameters:

- auger conveyer output 12 t/h
- screw diameter 200 mm
- screw lead 200 mm
- auger revolution frequency 78/min
- transport distance 18 m
- installed output 4kW.

Table 7. Grain damage by auger conveyer – horizontal transport, output 10.8 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before auger elevator	behind auger elevator	increase caused by auger elevator	before auger elevator	behind auger elevator	increase caused by auger elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Alana	791	13.90	0.36	0.64	0.28	1.33	2.91	1.58
				0.39	0.58	0.19	1.48	2.79	1.31
2	Alana	793	14.10	0.38	0.65	0.27	1.42	2.05	0.63
				0.31	0.63	0.32	1.45	2.86	1.41
3	Alana	793	14.10	0.33	0.59	0.26	1.49	2.95	1.46
				0.31	0.60	0.29	1.37	2.93	1.56
Total average			14.03	0.34	0.61	0.26	1.42	2.62	1.32

To Table 7 belongs graph in Fig. 7

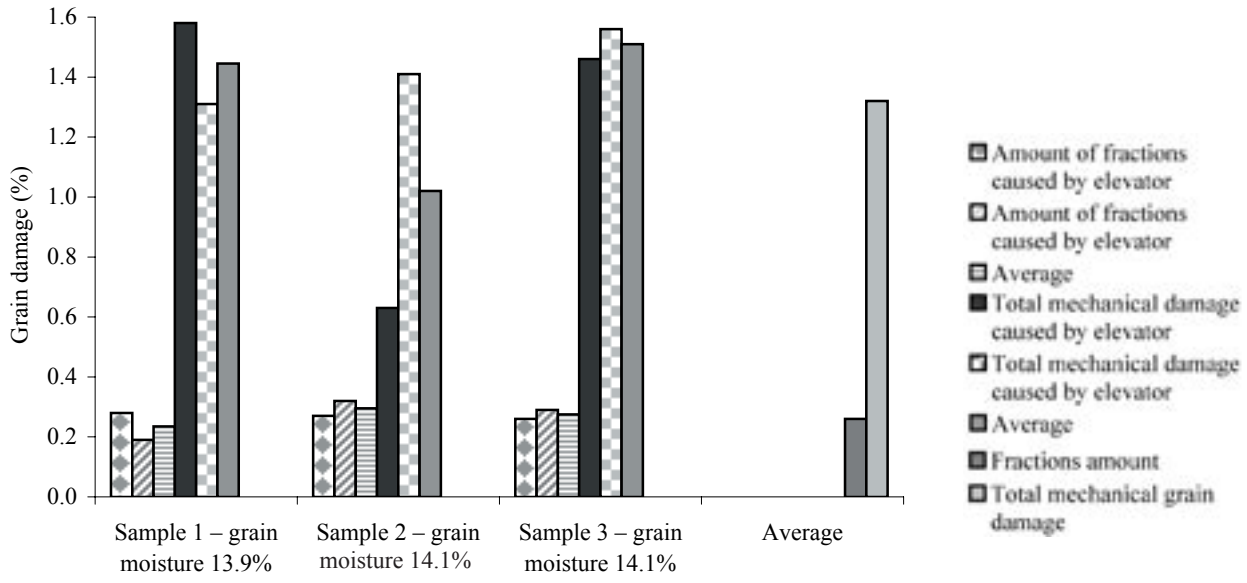

Fig. 7. Grain damage by auger elevator, performance 10.8 t/h, food wheat Alana

Basic technical parameters:

- anger conveyer output 12 t/h
- screw diameter 200 mm
- screw lead 200 mm
- auger rotation frequency 78/min
- transport distance 18 m
- installed output 4 kW.

Table 8. Grain damage by auger elevator – horizontal transport, output 28.8 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before auger elevator	behind auger elevator	increase caused by auger elevator	before auger elevator	behind auger elevator	increase caused by auger elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Niagara	780	14.30	0.31	0.77	0.46	0.58	2.31	1.73
				0.36	0.77	0.41	0.51	2.17	1.66
2	Niagara	786	14.20	0.24	0.57	0.33	0.63	1.99	1.36
				0.33	0.77	0.44	0.71	2.10	1.39
3	Niagara	782	14.00	0.31	0.80	0.49	0.69	2.30	1.61
				0.41	0.92	0.51	0.55	2.24	1.69
Total average			14.16	0.32	0.76	0.44	0.61	2.18	1.57

To Table 8 belongs graph in Fig. 8

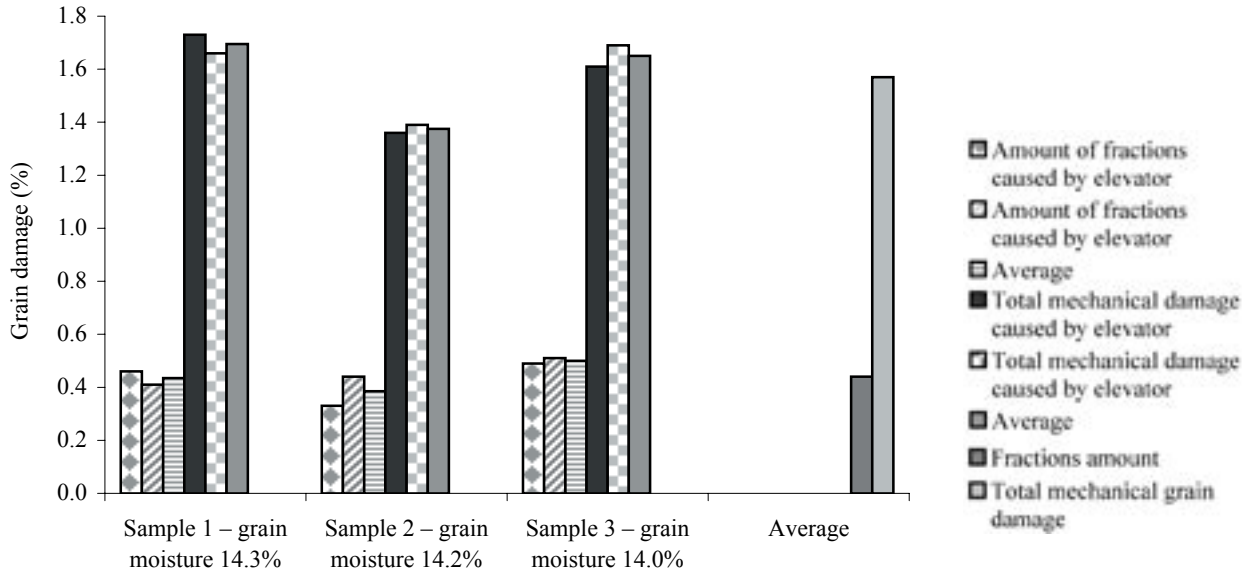

Fig. 8. Grain damage by auger elevator, performance 28.8 t/h, food wheat Niagara

After the summarized knowledge evaluation the following conclusion can be stated:

- For the auger elevator (screw diameter 200 mm, screw lead 200 mm, auger revolution frequency 78/min, transport distance 18 m) the fractions amount ranged from 0.19 to 0.32%. Total mechanical damage ranged from 0.63 to 1.58%. The transported material was food wheat Alana of average moisture 14.03% and volume weight 791–793 kg/m^3.
- For the auger elevator (screw diameter 320 mm, screw lead 250 mm, auger revolution frequency 100/min, transport distance 20 m) the fraction amount ranged from 0.33 to 0.51%. Total mechanical damage ranged from 1.36 to 1.73%. The transported material

was food wheat Niagara of average moisture 14.16% and volume weight 780–786 kg/m^3. Performance class 32 t/h.

After the performed analysis of measured results it can be stated that the auger elevators with closed transport "trough" tend rather to the total mechanical damage of transported grain than to the fractions creation in contrary to the bucket elevators. This is caused mainly by the transported material fraction with the transport "trough".

The measured results have shown that for the auger elevators of performance class 12 and 32 t/h the transported material distance is the limiting factor of grain damage. This factor effects both fraction amount and total mechanical damage. The longer is the transport distance at the auger elevators with closed trough, the higher is the total mechanical damage of transported grain. The grain transported by the auger elevator is being damaged even in the grain input to the elevator and at its output from the auger elevator.

The belt elevators

Basic technical parameters:

– chain elevator performance	80 t/h
– transport distance	10 m
– belt width	650 mm
– transport belt velocity	1.6 m/s
– installed output	1.5 kW.

Table 9. Grain damage by belt elevator – horizontal transport, output 68 t/h

Sample	Crops	Volume weight	Grain moisture	Fraction amount			Total mechanical damage		
				before belt elevator	behind belt elevator	increase caused by belt elevator	before belt elevator	behind belt elevator	increase caused by belt elevator
		(kg/m^3)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Brea	770	14.30	0.06	0.08	0.02	0.23	0.26	0.03
				0.02	0.03	0.01	0.20	0.21	0.01
2	Brea	734	14.10	0.03	0.05	0.02	0.22	0.27	0.05
				0.05	0.06	0.01	0.49	0.52	0.03
3	Brea	763	14.50	0.01	0.04	0.03	0.38	0.40	0.02
				0.09	0.10	0.01	0.40	0.48	0.08
Total average			14.30	0.04	0.06	0.01	0.32	0.38	0.03

To Table 9 belongs graph in Fig. 9

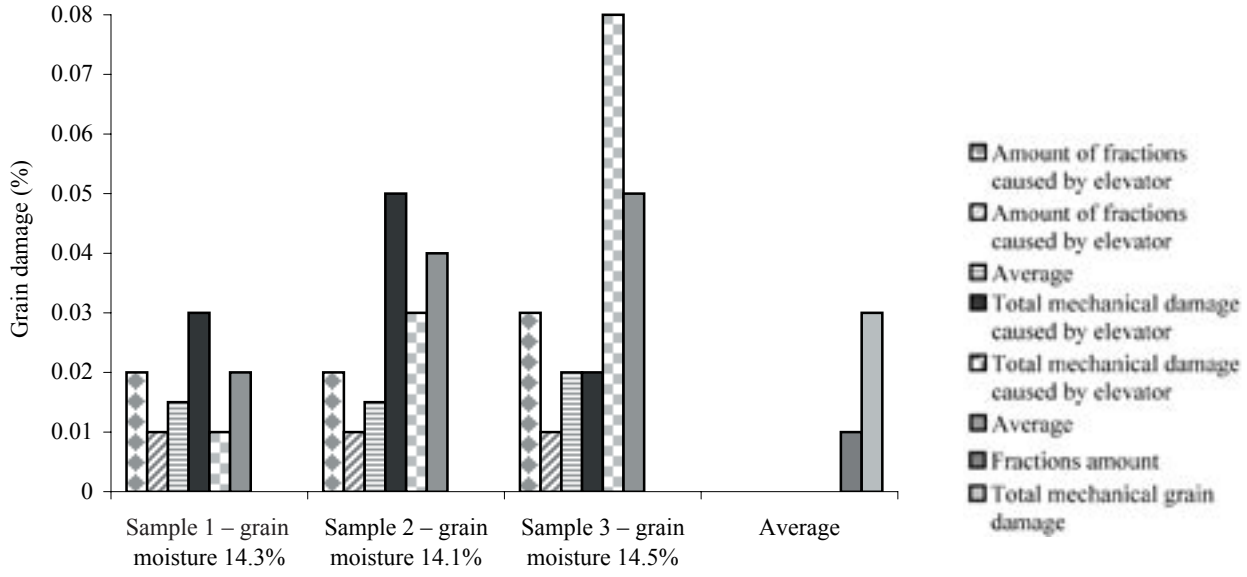

Fig. 9. Grain damage by belt elevator, performance 68 t/h, food wheat Brea

After the evaluation of summarized results the following conclusions can the stated:

– For the belt elevator with grain horizontal transport and transport distance 10 m the fraction amount ranged from 0.01 to 0.03%. Total mechanical damage ranged from 0.01 to 0.08%. The transported material was food wheat Brea of average moisture 14.3% and volume weight 734–770 kg/m^3, but for a reason of lower volume weight it does not meet demands for food wheat. Performance of that belt elevator is 68 t/h.

From the measured results it is evident that the belt elevators are friendly to the transported grain and this is suitable for grain horizontal transport in lines for reception, treatment and storage of food grain crops.

DISCUSSION

By evaluation of the summarized results can be stated that grain handling is a source of great mechanical damage. The largest share of transport in existing post-harvest lines is provided by bucket, chain, auger and belt elevators.

For bucket elevators the grain biggest damage was found at their parallel filling. The measured values showed the increased amount of fractions and total mechanical damage. The fractions amount ranged from 0.63 to 0.85% and total mechanical damage ranged from 0.39 to 0.58%. This tendency is probably caused by the fact, that at parallel filling the bottom part of the elevator is filled more and thus trajectory of the buckets in the grain layer is longer. From this results that grain at the parallel filling faces multiple hits to the buckets edges in comparison with filling against the buckets. Grain total damage at bucket elevators transport is also influenced by technical state of the bucket elevators, mainly their wear (e.g. front edge of buckets).

For the chain elevators (redlers) the biggest damage of the transported grain was reached mainly at a performance lower than the nominal one. The transported grain mechanical damage ranged from 1.78 to 1.98%. The grain transported by the chain elevator is being damaged at the grain input into elevator, during its own transport and output from the chain elevator. The grain damage extension will be affected by the elevator skate and transport distance (elevator length).

For the auger elevators with closed "trough" the grain total mechanical damage ranged from 1.36 to 1.73%. There elevators are a source of damage mainly for malt barley. Fortunately, in existing lines there elevators are used minimally.

For the belt elevators the transported grain minimal damage was reached, total mechanical damage has ranged from 0.01 to 0.08%, these elevators are friendly to the transported grain and thus are suitable for grain horizontal transport in lines for reception, treatment and storage mainly of food grain.

Importance of an even small reduction of grain damage by bucket, chain, auger and belt elevators in given by fact, that it concerns the multiple handling so the grain resulting damage can not be neglected. Every reduction of grain damage in the post-harvest lines increases the grain market production.

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Ztráty na vnější kvalitě při manipulaci se zrnem při jeho posklizňovém ošetřování

ABSTRAKT: V práci jsou uvedeny výsledky zjišťování ztrát na vnější kvalitě při manipulaci se zrnem při jeho posklizňovém ošetřování. Cílem bylo zjišťování poškozování zrnin při dopravě korečkovými elevátory typu „SANFON" při obvodové rychlosti korečků 2,0 m/s a 2,8 m/s výkonnostní řady 40 t/h a 80 t/h. Poškození bylo zjišťováno při protiproudém a při souproudém plnění korečků. Z naměřených výsledků plyne, že korečkové elevátory mají sklon spíše k drcení zrna – tj. k vytváření zlomků – než k drobnějšímu poškozování. Řetězové dopravníky – redlery nemají na základě dílčích poznatků takový sklon k vytváření zlomků, ale mají výrazný sklon k celkovému mechanickému poškozování dopravovaného zrna zejména při výkonnosti podstatně nižší, než je výkonnost jmenovitá. V tomto případě se celkové mechanické poškození pohybovalo v rozmezí 1,78 až 1,98 %. Šnekové dopravníky mají spíše sklon k celkovému mechanickému poškozování dopravovaného zrna než k vytváření zlomků; je to způsobeno především třením dopravovaného zrna o dopravní „žlab". Celkové mechanické poškození se pohybuje v roz-

mezí 1,36–1,73 %. Pásové dopravníky jsou šetrné k dopravovaným zrninám, a proto jsou vhodné pro horizontální dopravu zrna u linek na příjem, ošetřování a skladování potravinářských zrnin.

Klíčová slova: vnější kvalita; korečkový elevátor; řetězový dopravník; šnekový dopravník; pásový dopravník; zlomky; celkové mechanické poškození; zrno

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