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The Debranning of Common Wheat (*Triticum aestivum* L.): An Innovative Tool for Improving Grain Characteristics

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Introduction

Wheat requires an adequate milling process to obtain flour, the principal raw material for bread and many other baked products. The wheat kernel is characterized by a particular shape, with a deep crease along the length of its longitudinal axis (Figure 1). Due to this morphological trait, a special process of wheat grinding was set up. **The milling process extracts flour from the endosperm by breaking the kernel and removing the tegumental layers (with numerous operations/in various steps) which proceed from the inside towards the outside of the kernel.**

Another process which removes bran layers is debranning, largely used in the rice industry.

In this case, the removal is progressive, proceeding from the outside layers towards the more internal regions, allowing the recovery of intact kernels that are differently processed at a later stage.

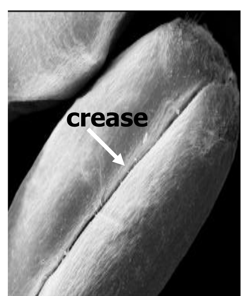

Figure 1.
Wheat kernel

In the case of wheat kernels, the complete removal of bran by the debranning process is unsuccessful as parts of the teguments remain inside the crease, whatever the debranning level.

In order to obtain flour, the debranned kernels have to be milled by conventional milling. Recently however, positive results have been obtained by debranning durum wheat (*Triticum durum L.*) kernels, estimating that semolina yield of debranned kernels could be 5% higher than after conventional milling and that there is an increase in the quality of semolina pasta making (Pagani et al. 2000).

Aim

The effects of different debranning conditions on the properties of common wheat (*Triticum aestivum* L.) kernels were investigated with particular attention given to the amount of broken kernels and to the starch content in debranning by-products. Both these aspects, in fact, can affect the flour yield and quality.

Moreover, the effect of debranning on the microbial contamination in the finished products was evaluated. The removal of the external layers of the kernels before milling can also improve their hygienic characteristic.

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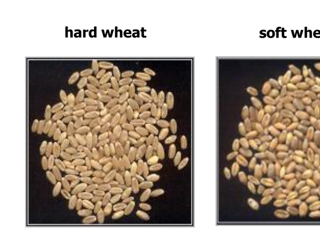
Materials and Methods



Two hard wheat samples and two soft wheat samples were used in this study (crop 2004 and 2005).

Figure 2.
Pilot-plant debranning machine
(M300MINI, C.M.F.,Brescia, Italy)

A pilot-plant debranning machine (Figure 2) equipped with innovative abrasive elements lined with synthetic diamond powder® was used. Different variables were taken into consideration during the process, as summarized in Table 1.

Pre-hydration of kernels (% H_2O)	Kernel treatment after pre-hydration	Particle size of the abrasive elements	Debranning time and n° debranning steps
0	resting - 0 min		5 min x 1 step
2	resting - 5 min	Millstones A (MA): 80÷120 mesh	2 min x 1 step
3	resting - 20 min	Millstones B (MB): 180÷200 mesh	2 min x 2 steps
	mixing - 6 min		2 min x 3 steps

Table 1.
Variables taken into consideration during the debranning process

All variables described in Table 1 were variously combined and the total debranned samples, coded D, were 32. Twenty-four trials were carried out using the debranning elements with a coarse abrasive surface (MA), whereas 8 trials were performed by using debranning elements with a finer abrasive surface (MB).

Further experiments were performed with MB, in order to include a final brushing step after the debranning process.

All samples were evaluated by:

- **physical analyses:** debranning level (DL); broken kernel amount.
- **chemical analyses:** moisture content; total starch.
- **ultrastructural observation (SEM)**
- **microbiological analyses:** mesophilic aerobic bacterial count; eumycetes.

Results and Discussion

Laboratory scale debranning: the use of Millstones A (MA)

This first set of trials was carried out to identify suitable conditions for an optimal debranning process, which means a small amount of broken kernels and a limited abrasion of the endosperm. Previous studies on durum wheat (Pagani et al. 2002) demonstrated that **DL levels higher than 10-12% were related to excessive endosperm abrasion and loss of starch in by-products.**

In the present study, the DL obtained in the first set of trials (n=24) carried out on Millstones A (MA) was higher than 10% for 8 samples (*D1, D4, D5, D6, D7, for hard wheat; D17, D18 for soft wheat*), all processed by a single debranning step of five minutes (Figure 3).

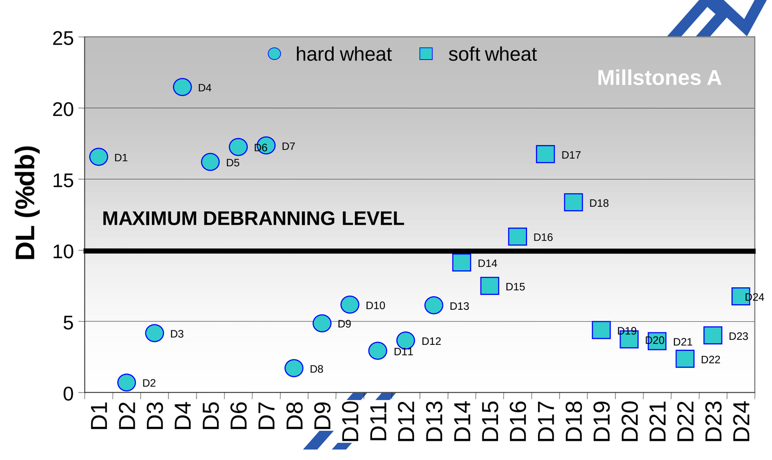


Figure 3.
Debranning level of kernels (DL%)

Figure 4 shows the amount of starch lost in the by-products. **The higher the DL, the higher the starch content in the waste products. The amount of starch wasted with by-products was in fact related to the DL** (r=0.90; p<0.05).

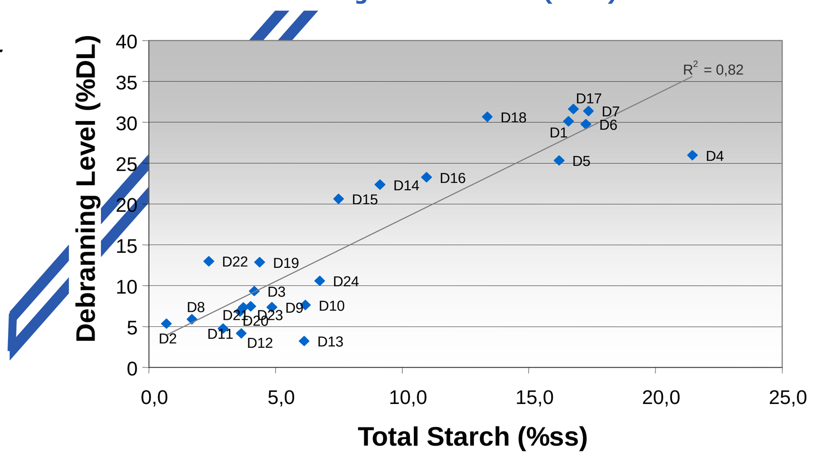


Figure 4.
Correlation between by-products starch content and Debranning Level (DL%)

The effects produced by different debranning conditions on the grain surface were evaluated by SEM (Figure 5). **The action of MA** covered by coarse abrasive elements **was not homogeneous** in either the hard or the soft wheat kernels, apart from the debranning conditions applied and the debranning level. **The bran layers were still present on some surface areas while in other regions the starch granules of endosperm were clearly recognizable** as a consequence of an excessive abrasive action. Moreover, many "cuts" were observed on wheat surfaces, and these were deeper in the case of hard kernels.

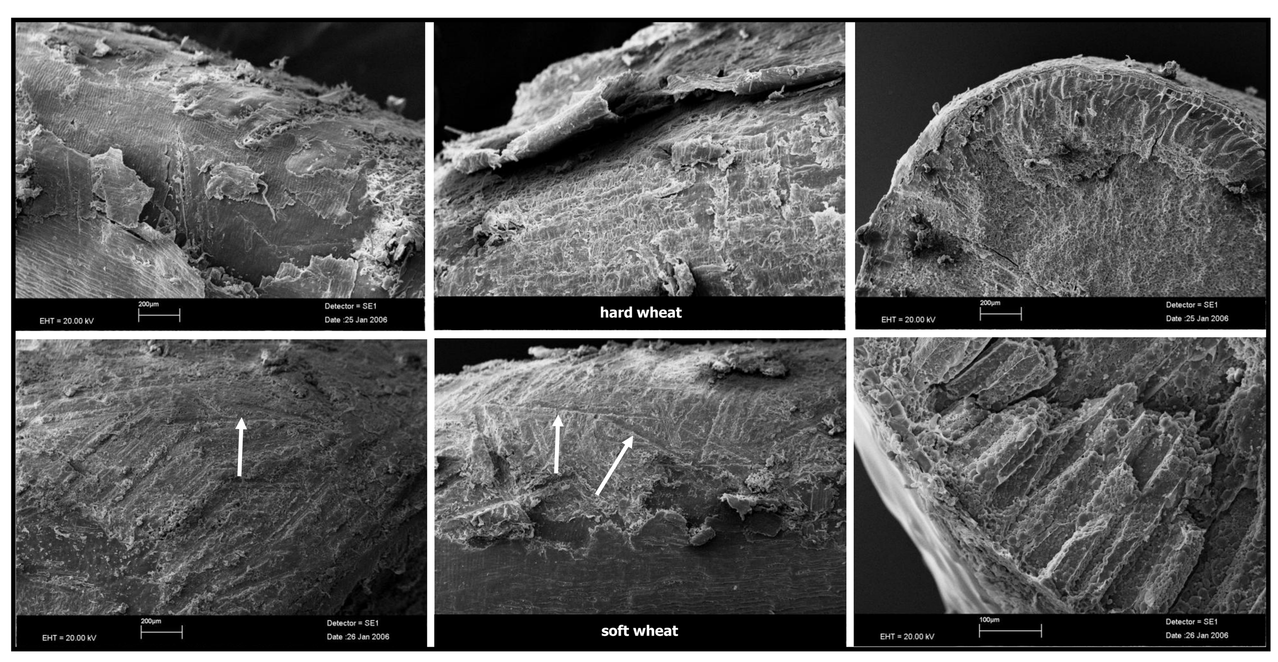


Figure 5.
SEM images of hard wheat and soft wheat kernel after debranning with MA abrasive elements
(the white arrows show the "cuts" caused by MA on the kernel surface)

Laboratory scale debranning: the use of Millstones B (MB)

Taking into account the previous results, the need for some change in the millstones abrasive properties appeared necessary. The debranning machine was thus equipped with identical abrasive elements lined with finer synthetic diamond powder® (Millstones B, MB).

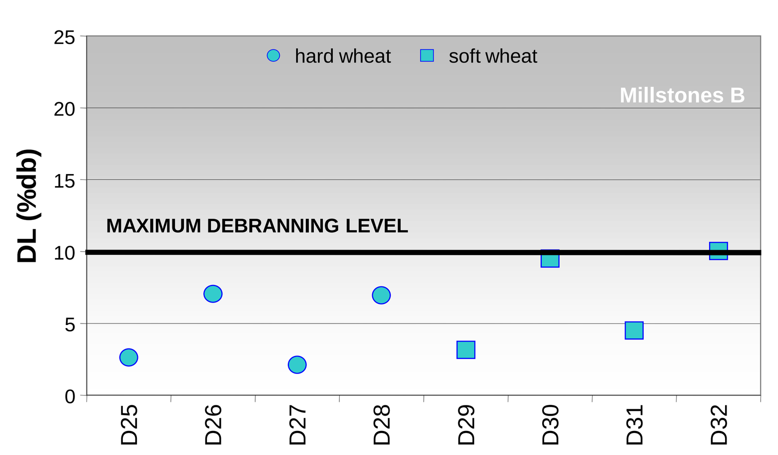


Figure 6.
Debranning level of kernels

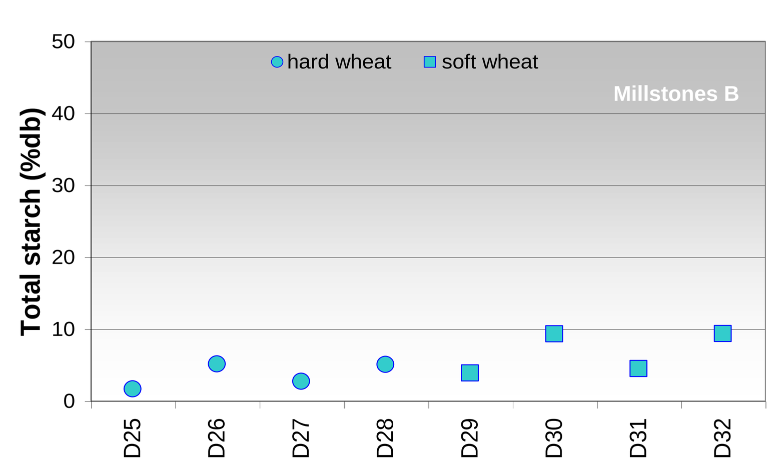


Figure 7.
Total starch content of waste

Figure 6 shows the DL associated with the new processing conditions: all the samples were characterized by DL equal to or lower than 10% db. **The amount of starch in the by-products was related to DL** (r^2=0.90; p<0.05) **and never exceeded 10 %db** (**Figure 7**). These values are very close to the starch content of bran obtained from the conventional milling process. The use of these new abrasive elements also caused a general decrease in the amount of broken kernels during the process (data not shown).

The new **MB debranning elements determined a strong abrasive action** (**Figure 8**). In particular, after 1 step with the new system, the external layers of hard wheat grains were raised but still attached to the kernel, mainly in the crease. Even after 3 debranning steps, the debranning action was good but not complete: many raised layers could be observed. **Nevertheless, all the incisions originated by MA were no longer present in the MB debranned kernels.**

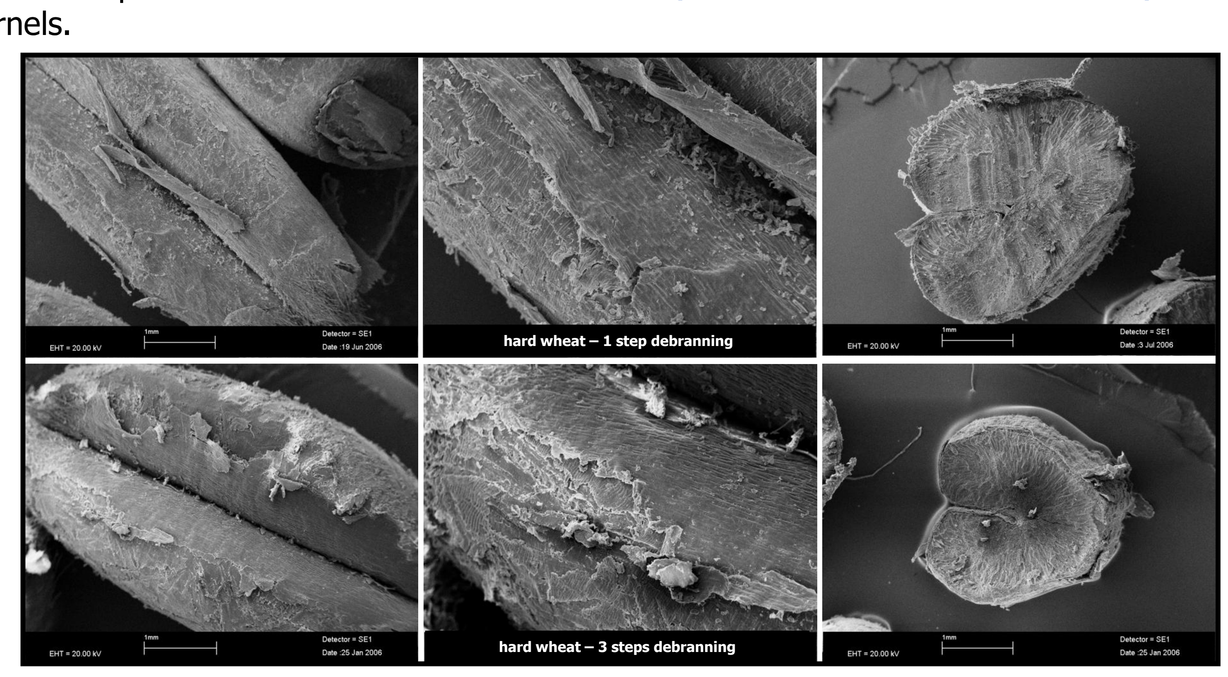


Figure 8.
SEM images of hard wheat after 1 step or 3 steps of debranning by MB abrasive elements

A further experimental step on a pilot-scale was carried out using a **brushing machine after debranning.**

The presence of raised layers could originate small bran particles and, therefore, decrease the flour quality. **The brushing operation allowed to obtain a smoother surface of the kernels** (**Figure 9**).

Figure 9.
Hard wheat kernels after 1 or 3 steps of debranning by MB and brushing

Effect of debranning on the microbial contamination of the kernels

The microbial quality of grains is of great importance for product safety. Generally, grains of good hygienic quality show a microbial population represented by 10^4 -10^5 CFU/g of bacteria, 10^4 CFU/g of yeasts and moulds (Franzetti et al. 1997).

The **debranning** trials carried out using the MA **allowed a considerable microbial reduction** in the case where the grains were pre-hydrated with 3% H_2O (w/w) and submitted to 3 debranning steps (**Figure 10**).

The same positive trend was observed using the MB with a finer abrasive surface: **the microbial contamination was 90-95% lower after debranning** (**Figure 11**).

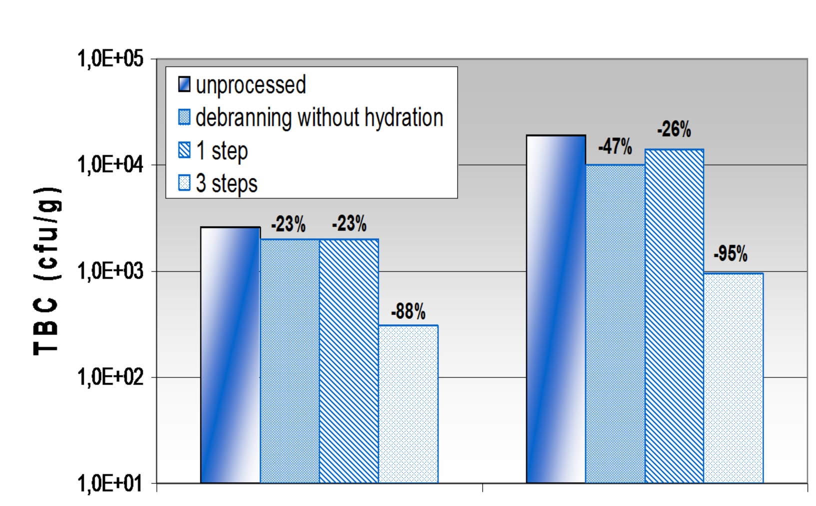


Figure 10.
Effect of the debranning process with MA on the microbial contamination of the wheat kernels.

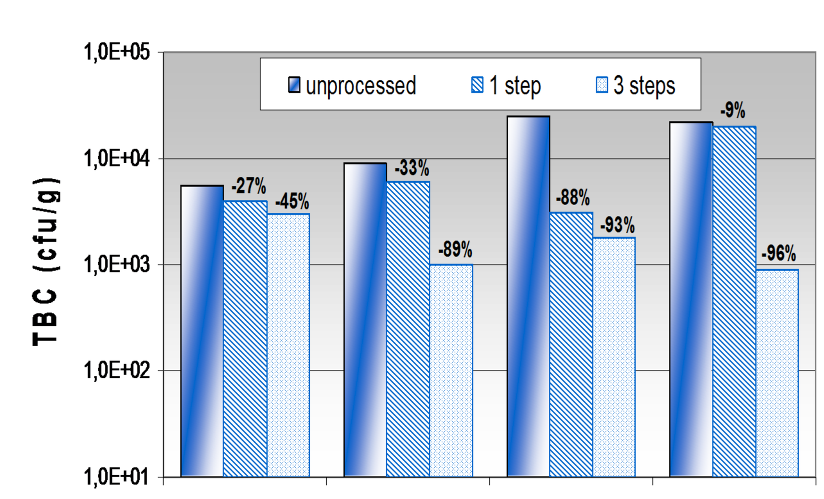


Figure 11.
Effect of the debranning process with MB on the microbial contamination of the wheat kernels.

Conclusions

Among the different debranning trials performed in this study, the best results were related to a Debranning Level (DL%) equal to 8-10%, obtained when the following conditions were applied: pre-hydration of the kernels with 3%w/w of tempering water, few minutes of resting time in mixing conditions and reduced length of the debranning process. The use of finer synthetic diamond powder® (MB) increased the positive effects of this pre-treatment, allowing the decrease of penetration of the debranning action into the endosperm, the reduction of starch waste in the by-products and the decrease of the number of broken kernels during process. Finally, this pre-treatment reduced the microbial contamination and could facilitate the subsequent steps of the milling process, as the grains would already be lacking in bran.

References

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