FILTH TEST APPLICATION IN ROUTINE QUALITY CONTROL IN BREWERIES

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Summary

Reasons that justify a research on the conditions of the raw materials used in a brewery are reported here. The presence of solid impurities is indicative of the hygienic conditions of the premises of the brewery and of the storage bins where maize and malted barley are stored. Previous in-field or current pest infestations may cause great economic losses since they reduce both the quality and the quantity of agricultural product. Such infestations may: 1) reduce the barley germination rate during malting; 2) promote fungal infection which can lead to mycotoxin production in the barley-malt chain; 3) alter the enzyme formation; 4) reduce the oil and resin content of hop cones.

It is important to remember that arthropods may be vectors of wild yeasts and spoilage bacteria that compromise the hygienic conditions of the premises where raw materials are processed with particular regard to sensitive areas where yeast is handled, beer is deposited for maturation and the final product is bottled and packaged.

Type 90 hop pellets, maize grits and barley kernel samples brewed in a brewery operating in Northern Italy were analysed. The methods used for the analyses are: 1) Filth test for hop pellets; 2) Filth test for maize grits, un-malted and malted barley; 3) X-ray examination for raw barley kernels only.

All samples showed a low level of impurities. In any case, the authors suggest the use of the filth test as a monitoring system which can evidence the hygienic conditions of the raw materials usually used in the malt and beer chain. Also, filth test can be a powerful tool which can support the stakeholder in assessing the hygienic standards of premises.

Keywords: brewery; filth test; x-ray examination; raw materials; pests

Introduction

Beer is made from cereals. Malted barley is the main raw materials for beer production. Un-malted cereals such as maize, wheat, rice, barley, sorghum, millet, oats and rye are often used as adjuncts. Such cereals may be subjected to damage by pests. Defects in raw ingredients and finished products can lead to wasted goods, affect supplier relationships, and alienate customers. Moreover products in violation of DAL's as set by the U.S. Government, the E.C. or the Italian Regulations are not to be processed or placed on the market for sale to the public**.** As a consequence it is important to check the presence of previous or current infestations in the raw materials for many reasons.

1) Arthropods that pest raw materials can be a sign of a non-respect of the hygienic standards of the production by the Quality Managers of the industry;
2) Pest infestations are a clear sign of the inefficiency or inadequacy of the pest control system adopted by the brewing quality management:
3) Pests can be a sign of the poor quality of the raw material processed. The grain and the hop attacked by arthropods can undergo changes in chemio-phyisical properties that may reflect upon the quality of the finished beer;

4) The grain attacked during growing, harvesting or storage by *Sitophilus spp.* (Coleoptera Curculionidae) can have a reduced germination rate during malting;
5) Aphids and mites that infest hop plants during growing , attacking leaves and cones, reduce the content of bitter resins and ethereal oils;
6) Infestations can be a sign of the quality in the operations of supplying, production, handling and storage by the selected suppliers;
7) The respect of the current national and European regulations in matter of food production, security and hygiene can not be violated.

Moreover arthropods , mainly the ones that are routinely found in a brewery, such as the small fruit flies (Diptera, Drosophilidae) and the honey bees (Imenoptera, Apoidea) may function as vectors of wild yeasts and/or spoilage bacteria. Wild yeast and spoilage bacteria such as lactobacilli and acetic acid bacteria may easily adhere to the arthropod body and survive inside escreta as they are able to remain vital after they have passed through the arthropod digestive system (Cocconcelli, 2003). When they pest plants and structures devoted to yeast pitching, propagation and storage within the yeast tank farm or the bottling departments they can easily reduce the environmetal hygiene of premises. For this and many more reasons arthropod infestations on grain and hop cones should never be underestimated and in any case the presence of arthropods within the premises of a brewery is to be neglected. Pest growth depends on the microclimatic conditions, the shape of the architectural structures, the staff behaviours and on the measure of prevention and control adopted by the quality assurance staff managers of the production facilities.

Breweries are complex ecosystems where arthropods, rodents (such as *Rattus rattus*, *Rattus norvegicus*, *Mus domesticus*), bats (Rhinolophidae and Vespertilionidae), urban birds (such as *Columba livia var.domestica*, *Streptopelia decaocto*, *Sturnus vulgaris*, various species of Larids and Raptors) adapt themselves exploiting the ecological variables to complete their own biological cycle. The presence of insects belonging to various orders in breweries has already been pointed out in literature in works that have applied specific monitoring systems (Mochiyuky, 1968, Fahy, 1971; Hunter et al., 1973; Tanyongana, 1983; Jacobson, 1985; Donadini, 2000, Donadini et al. 2004).

In the light of what is said above though, it should also be important to check the raw material conditions before their use to ascertain if they are or have been infested by insects. Having suffered an infestation they could present unsatisfactory technological, hygienic and legal conditions for their use. Additionally raw materials are one of the main route by which arthropods may enter the production lines.

Filth test is a powerful tool to investigate the presence of any foreign matter in products associated with objectionable conditions or practise in production, storage or distributions. The filth test method is applicable to the enumeration of extraneous material light filth elements such as insect fragments, mites, hairs and feather barbules and heavy filth particles such as sand, soil, metal, glass, insect and rodent excreta pellets. Methods are each relatively simple to use: 1) They have sufficient accuracy for quality control; 2)They do not require sophisticated or expensive equipment. 3) They do not require a high level of skill to operate. 4)They are sufficiently inexpensive that they may be used regularly by the quality control staff; 5) They take 45 minutes to be performed

X-ray examination on un-malted barley kernels can evidence the presence of holes and tunnels produced by insects whose larvae are used to devour the kernel endosperm such as *Sitophilus spp.* (Coleoptera, Curculionidae). X ray examination is cheap and no time consuming: It takes no more than 30 minutes to be performed. Unfortunately this rapid m*ethod* of test for hidden insect infestation is a scarcely used technique as a consequence of the fact that the X-ray apparatus is really expensive which make it unsuitable for routine applications. Filth test application and X-ray examination results are reported here. Our data evaluate the identity, quality, composition and level of extraneous

materials that contaminate raw materials (hop, maize, raw and malted barley) routinely used in the production of a portfolio of lager and specialty beers by one of the main producer within the Italian marketplace during the biennium 2004-2006. Filth test on maize grits only was previously used by the researchers of the Institute of Entomology in a survey whose main aim was to evaluate the environmental hygiene of silos during the storage of raw materials of the same brewery (Donadini et al., 2000).

Materials and Methods

Raw materials used in a brewery located in Northern Italy were analysed according to filth test and X-ray examination. Raw materials (maize grits, raw barley and malted barley kernels and hop type 90 pellets) were delivered to the brewery during the biennium 2004-2006.

Filth test methods used in this work for hop and barley are set up by A.O.A.C. (A.O.A.C., 2000). Filth test method used for maize is published on the Italian Gazzetta Ufficiale (G.U., 1999).

20 Maize samples from different Italian producers operating in Northern Italy were analyzed in compliance with the Italian official filth test method; This method commonly known as “method of the acetic-nitric digestion” can be applied to a wide range of products made from cereals. A 50 g. sample is digested in a solution of acetic acid and nitric acid. After 15 minutes gasoline is added to the solution and the consequent flotation carries the filth at the upper surface of the liquid. After filtration, impurities remain trapped onto a filter paper. The filter paper is examined to detect the nature of filth using a stereoscope. The AOAC 941.16 – Filth in Grain Products is an alternative method widely used. Unfortunately this method generates phosgene, a toxic gas that requires extra caution during the application of the analytical procedure. The Italian method is to be preferred mainly for this reason.

15 different hop cultivar samples from the North American and Central Europe crops have been analyzed in compliance with the AOAC 967.23 – Aphids in Hop. 10 g. sample of hop powder is boiled in a saturated borax solution for 90 minutes. The addition of heptane promote the filth flotation. Afterwards the analysis follows the same steps as for the maize grit analysis.

12 samples of winter and spring malt from three maltsters from the E.C. were analyzed in compliance with the AOAC 950.86 – Light Filth in Grain and Seeds. A 225 g sample is boiled with alcohol for 5 minutes. At the end of the boiling process heptane is added. After the flotation the filth is trapped off, and filtered prior to microscope examination.

14 un-malted barley samples from two European maltsters were X-rayed in compliance with ISO/TC 34/SC 4/WG 2 N 124 – Cereal and Pulses – Method of test for hidden insect infestation – Part 4 – Rapid Methods of Detection and Determination. For the X-ray examination a General Electric X-Ray Inspection Unit Model CH, type 1, n° 465316 was employed. The instrument has a beryllium window X-ray tube. The films were exposed for 5 minutes with the Unit tuned up at 5 mA and 21 kV. Each samples weighed 130 g and contained approximately 3700 kernels.

Results and Discussion

In regard to the filth tests, the hop pellets, the barley kernels and the maize grits showed almost the complete lack of impurities (see table 1 and 2 for more details). The low level of contamination in the raw materials analysed during this research is in agreement with the results of a previous survey carried out on maize grits only (Donadini et al., 2000).

In that work 10 samples were analysed with the Italian official filth test method (G.U., 1999). The insect fragment average for each sample was from 2 to 8; only one sample reported 13 arthropod fragment and 1 mite (Mesostigmata).

The insect fragment limit allowed by FDA is 25 per 25 g. of maize grits (FDA, 1998). So the results of the filth tests in this research put the maize grits samples under the threshold fixed by FDA.

In regard to hop pellets, the FDA limit for aphid fragments is 2.5 per 10 g. of product. So the results of our analyses showed acceptable hygienic requirement for the hop too.

In regard to raw barley kernels, FDA do not fix limits for any kind of filth. In any case the analyses showed the lack of insect fragments and other impurities and consequently the samples are to be regarded appropriate as human foodstuffs.

Only 7 out of 14 X-rayed samples showed kernels with insect tunnels. The number of damaged kernels ranged from 2 to 4. In any case the tunnels showed living or dead insects, whole or in fragments. X-ray examination results are in agreement with the filth test observations.

On the whole, the analyses are a proof of acceptable conditions of the raw materials in the brewery and it is possible to deduce that hop, corn and barley are preserved with the required care to prevent risks of infestation either at the producer or at the supplier.

As we know how easy infestations can also start in environments where the integrated pest management is carried out with great care, it seems right to suggest to the heads of the Quality Control the use of the filth test with regular attendance, and to regard it as a routine analysis, to verify the conditions of the raw materials and to monitor the environments where they are transformed and stored.

Surely the filth test can't be considered an analysis able to replace all the other monitoring systems and it can support them effectively to supply continuously a more complete and up-to-date summary of the situation.

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	Hop	Barley
1	Yakima Millennium	Esterel
2	Hallertau Hallertauer	Astoria
3	Hallertau Hallertauer Magnum	Scarlett
4	Hallertau Hallertauer Tradition	Winter Barley Regina
5	Hallertau Spalter Select	Winter Barley Peak
6	Hallertau Taurus	Winter Barley Carat
7	Hallertau Hersbrucker	Spring Barley Cellar
8	Hallertau Perle	Spring Barley Optic
9	Hallertau Northern Brewer	Landora
10	Spalt Spalter	Lux
11	Tettnang Tettnanger	Optic
12	Galena	Altiay
13	Willamette	
14	Cascade	
15	Saaz	

Tab. 1 – Hop cultivars (type 90 pellets) and unmalted barley kernels analysed.

sample	Weight of the sample	N° of kernels	Bored kernels
Esterel 1	130	3700 ~	0
Esterel 2	130	3700 ~	0
Astoria	130	3700 ~	2
Scarlett	130	3700 ~	1
Winter Barley Regina	130	3700 ~	0
Winter Barley Peak	130	3700 ~	1
Winter Barley Carat	130	3700 ~	0
Spring Barley Cellar	130	3700 ~	0
Spring Barley Optic	130	3700 ~	4
Landora	130	3700 ~	0
Lux	130	3700 ~	1
Optic	130	3700 ~	2
Altiay	130	3700 ~	0
Optic	130	3700 ~	1

Tab. 2 – Results of the X-ray examination on barley kernel samples.