

# The Influence of Corn Syrup Based Solid Food Supplements during the Inactive (Winter) Season upon the Evolution of Major Bacterial Diseases in Bees

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## Abstract

We aimed to establish the influence of corn syrup on clinically healthy bee families, which however carry etiologic agents of major bacterial diseases in the winter. Five apiaries in the South of Romania were monitored in terms of bee colonies' health as part of a research program. Bee samples were received at the end of the active season before administering food supplements, and after winter, for lab testing, from 75 bee colonies treated during the inactive season with fructose syrup based food supplements. By comparison, 25 bee colonies were treated naturally (with reserve honey). The samples were investigated macroscopically and microbiologically (direct microscopy and bacterioscopic tests), noting massive presence of bacilli and spores only in the samples of bee colonies that had been fed corn syrup based food supplements, and not in the control lot. The bees that have been fed naturally did not present changes of intestinal microflora. Feeding corn syrup based supplements in the solid food during the winter season influenced negatively the development of bee colonies and caused depopulation, apathy, shorter life. The microscopic investigation allowed showcasing the boom of bacilli in bees' intestine. Corn syrup based food supplements fed to bees in the winter altered the microflora balance and permitted the development of major bacterial agents. Preventive examination of bees' intestine by direct microscopy and subsequent confirmation by microbiological testing before feeding are recommended.

**Keywords:** *Apis mellifera*, European foulbrood, American foulbrood, food supplements

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## INTRODUCTION

During the inactive period (winter), when the reserve food is insufficient to feed the bee families, they are fed corn syrup based solid food supplements with various added solid nutrients (pollen, pollen substitute, honey). Supplementary food is necessary when bees do not have sufficient reserve honey in the winter, thus avoiding losses from starvation (ACA, 2012; ACA, 2011). Supplementary food, based on solid food in the form of cakes containing corn syrup, has become a practice among beekeepers due to its

advantages in terms of cost, storage, distribution and transportation. Resulting from corn syrup degradation and from fructose-rich honey degradation is hydroxyl-methyl-furfural (HMF), which is toxic for bees and for people (LeBlanc *et al.*, 2009). In bees, the toxicity of hydroxyl-methyl-furfural is manifested in symptoms similar to dysentery, caused by ulceration of the intestinal tract, which triggers significant losses in the bee colonies that are artificially fed with corn syrup (Zirbes *et al.*, 2013), as result of the accumulation of high amounts of HMF (LeBlanc *et al.*, 2009). Large-scale use of honey substitutes, including corn syrup,

**Tab. 1.** Distribution of bee colonies in the monitored colonies

No. of bee colonies Experimental lot (fructose-corn syrup)					No. of bee colonies Control lot (reserve honey fed)				
75					25				
ApiaryA	ApiaryB	ApiaryC	ApiaryD	ApiaryE	ApiaryA	ApiaryB	ApiaryC	ApiaryD	ApiaryE
6	12	14	16	27	5	5	5	5	5
Laboratory test (direct microscopy) / (before start of inactive season in which only presence of bacilli was identified)					Laboratory test / (direct microscopy) (before start of inactive season in which only presence of bacilli was identified)				
Bacilli/cocci present Gram +					Bacilli/cocci present Gram +				

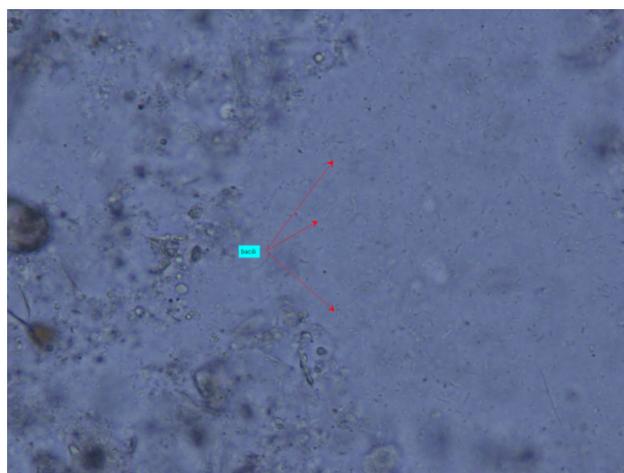
may affect bees' immunity system and its detoxifying capacity (Mussen *et al.*, 2012; Savu *et al.*, 2013).

The aim of this study was to determine the influence of solid supplementary corn syrup feeding in the winter on clinically healthy bee colonies, which however carry etiological agents of major bacterial diseases (American foulbrood and European foulbrood).

## MATERIALS AND METHODS

We monitored bee health in 5 apiaries in the Southern area of Romania as part of a research program (Tab.1). Bee samples were taken at the end of the active season *before* feeding supplements, and also *after* winter. Samples from 75 bee colonies treated during the inactive season with corn syrup in the solid supplementary food of bees were examined, in comparison with a control lot of 25 bee colonies fed naturally (with reserve honey). Each bee colony consumed a monthly ration of approximately 1 kg solid food each month for 3 months, according to protocols established by the beekeepers. The solid supplement for each bee colony had various amounts of corn syrup, as specified in each product's prospect. The supplements were selected depending on their source and the beekeepers' capacity.

Ten samples were examined clinically in the laboratory before feeding solid food supplements, two samples of live bees collected randomly from apiaries belonging to the supplementary feeding lot and to the control lot. In the direct microscopy test and in the bacterioscopic testing of the intestine of the carrying but clinically healthy adult bee, the presence of vegetative forms of etiological agents of major bacterial diseases: European foulbrood (*Melissococcus plutonius* and agents association - *Enterococcus faecalis*, *Achromobacter eurydice*,



**Fig. 1.** Experimental lot - Vegetative forms of etiological agents suspected of loca *before* supplementary feeding ( $T_0$ ) (microscopic test directly from the intestine) x 400

*Paenibacillus alvei*, *Brevibacillus laterosporus*) and American foulbrood (*Paenibacillus larvae*) were noticed (OIE, 2008) (Fig.1).

## RESULTS AND DISCUSSION

After supplementary feeding in the winter (3 months), necessity samples were taken (Tab. 2), as a result of the appearance of clinical manifestations of the disease. Samples were evaluated by direct microscopy and bacterioscopic examination when we noticed massive presence of bacilli, spores and association flora only in the samples from bee colonies that had been fed solid corn syrup food supplements. In the testing are, complete depopulation and mortality were noticed in the bees that had been fed solid corn syrup food supplements (after spring testing). The sample collected from naturally fed bees did not present changes of the intestinal microflora,

(hydroxymethylfurfural) (LeBlanc *et al.*, 2009;**Tab. 2.** Results of clinical evaluation and laboratory testing of bee samples sent for necessity examination (experimental lot and control lot)

Laboratory test at the end of the inactive season (Experimental lot)						Laboratory test at the end of the inactive season (Control lot)		
75 bee colonies of which:						25 bee colonies		
47 bee colonies (63%) presented bacilli (+++)			28bee colonies(37%) presented bacilli (++++)			bacilli (+)		
Depopulation in 39 bee colonies (52%)			Complete mortality in 36 bee colonies (48%)			100 % (survival)		
No. of diagnosed bee colonies suspected of European and /or American foulbrood (Experimental Lot)						No. of diagnosed bee colonies suspected of European and /or American foulbrood (Control Lot)		
EF	AF	EF / AF	EF	AF	EF / AF	EF	AF	EF / AF
9	11	19	24	8	4	-	-	-
(23%)	(29%)	(48 %)	(67 %)	(22 %)	(11 %)	-	-	-

EF\* (European foulbrood), AF\*\* (American foulbrood)

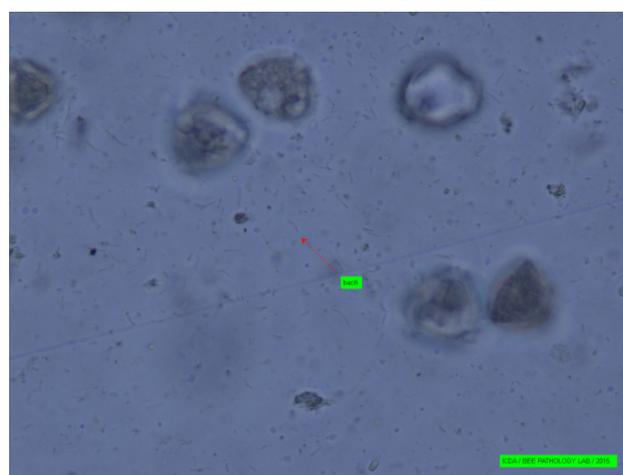
before and after the winter season, according to OIE methodology (OIE 2008; Savu, 2013) (Fig. 2).

Results indicated that in the experimental lot (75 treated bee colonies), 47 bee colonies (63%) showed the presence of medium degree of infection with etiological agents of major bacterial diseases, and 28 bee colonies (37%) showed the presence of massive infection (European and /or American foulbrood suspicion).

Clinical tests showed that depopulation after 3 months of feeding corn syrup based on solid food supplements was 52% (39 bee colonies) cases of medium degree infection, and complete depopulation in the cases of massive infection 48% (36 bee colonies). As regards the etiology of the infection, in the colonies of medium infection, European foulbrood was suspected in 23% (9 bee colonies), American foulbrood in 29 % (11 bee colonies) and mixed infection in 48% (19 bee colonies). For the apiaries of massive infection diagnosed in the laboratory, it was noticed that in 67 %, European foulbrood was suspected (24 bee colonies), in 22 % (8 bee colonies) American foulbrood and in 11 % mixed infection AF and EF (4 bee colonies) (Fig. 3, 4).

The hypothesis is that *the virulence and pathogenicity of etiological agent stems for major bacterial diseases was caused also by the type of product containing corn syrup, possibly correlated with the HMF content.*

There is a different aggressiveness of corn syrup on bees' intestine due to the content of HMF



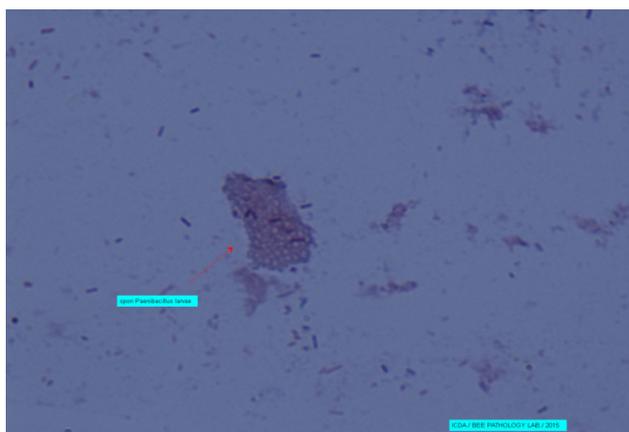
**Fig. 2.** Control lot (untreated) - Vegetative forms of suspected etiological agents of European and /or American foulbrood *after* supplementary feeding T<sub>1</sub> (3 months) (microscopic test directly from the intestine) x 400

Zirbes *et al.*, 2013).

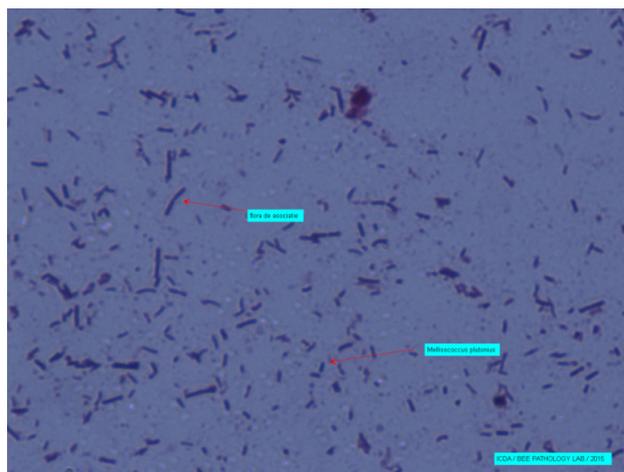
The presence of etiological agents leading to AF and EF suspicion (Fig. 3, 4) was at the base of the classification of apiaries that received supplementary corn syrup food according to the infection degree and to the dominance of etiological agents, AF or EF, respectively.

## CONCLUSION

Feeding solid corn syrup based supplements in the winter caused depopulation and even



**Fig. 3.** Highlighting the etiological agent and association flora for American foulbrood after feeding the supplement (Experimental Lot) (Gram coloured smear) x1000



**Fig. 4.** Highlighting the etiological agent and association flora for European foulbrood after feeding the supplement (Experimental Lot) (Gram coloured smear) x1000

mortality in bee colonies by perturbation of the balance of intestinal microflora.

Direct microscopic examination and bacterioscopic testing founded suspicions of European and /or American foulbrood as a result of disturbed balance of intestinal microflora.

The control lots that were naturally fed only with reserve honey did not present any modifications of intestinal microflora or clinical ones.

Corn syrup supplements caused the development of etiological agents of major bacterial diseases (suspected European foulbrood and American foulbrood) and multiplication of pathogens that was present before bees were fed with corn syrup.

Preventive direct microscopic examination of bees before feeding supplements and eventually confirmation by bacterioscopic tests is recommended.

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