# Effect on productivity of treating fattening pigs every 5 weeks with flubendazole in feed

## *Impact van een 5-weekse behandeling met flubendazole op de productiviteit van mestvarkens*

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**ABSTRACT**

**In a large European trial, a deworming program using 30 ppm flubendazole for 5 days every 5 weeks for fattening pigs was evaluated for a period of 16 months (4 rounds) and compared with untreated control and historical pre-treatment data from the same fattening units. The treatment regime was evaluated in 4 fattening farms located in Belgium, The Netherlands and France with a total of 21,721 fattening pigs in the treated and 22,394 in the control groups. All the farms, except farm A, had very low EPGs (Eggs Per Gram) for *Ascaris suum* before treatment and were nihil after treatment. In three of the farms a reduction in affected and rejected livers due to "white spots" was noted. In all the farms, positive effects on average daily weight gain (15.1 to 34.7 g) were obtained, except in farm C, and fewer dropouts were counted in the treated groups.**

SAMENVATTING

In een Europese cohortstudie werd over een periode van 16 maanden (4 ronden) een ontwormingsprogramma bij mestvarkens geëvalueerd waarbij 30 ppm flubendazole gebruikt werd gedurende 5 dagen, 5 weken lang. De resultaten werden vervolgens vergeleken met een onbehandelde controlegroep en met de historische gegevens van dezelfde bedrijven. De behandeling werd geëvalueerd in 4 mestvarkenbedrijven in België, Nederland en Frankrijk. In totaal werden er 21.721 mestvarkens behandeld en telde de controlegroep 22.394 dieren. Alle bedrijven, met uitzondering van bedrijf A, hadden een historisch erg lage EPG (Eggs Per Gram) score voor wat betreft *Ascaris suum*. Na de implementatie van het ontwormingsprogramma met flubendazole was de EPG-score van deze bedrijven nihil. In drie bedrijven werd er een verlaagd aantal getroffen levers en afgekeurde levers omwille van "white spots" opgemerkt. In alle bedrijven werden er een positief effect op de dagelijkse groei (15.1 tot 34.7 gram) en een verminderd aantal "drop-outs" in de behandelde groep vastgesteld.

## INTRODUCTION

The clinical symptoms caused by worm diseases in fattening pigs are mostly vague and unspecific. Consequently, pig farmers and veterinarians consider the economic importance of these diseases to be of low priority because inadequate information is available on their economic impact, and because at the current time there is only very limited interest in the development of innovative control programs.

Recent data on the epidemiological aspects of *Ascaris suum* and the latest discoveries on their life cycle (Roepstorff *et al.*, 1997; Fagerholm *et al.* 2000; Boes *et al.*, 2002) are having new consequences for deworming programs. A new approach is needed, especially for the prevention of white spots in the liver. The high prevalence of white spots observed in many countries in Europe is strongly indicative that ascarids are present on many farms.

The primary methods of control, such as minimizing parasite exposure in well managed confinement housing and the use of highly effective anthelmintics, do not always succeed in preventing herd infection with the large roundworm. Even steam cleaning and lye treatment of the flooring have been ineffective in removing all the worm eggs of the large roundworm (Urban *et al.*, 1989).

To reduce the prevalence of white spots, a control method must be highly efficacious and the control program must be based on the minimum pre-patent period of *A. suum*. Immatures ($L_5$) can already be treated between day 28 and 35 after infection, the first adults from day 42.

The period of larval migration through the liver, which causes milk spots, and through the lungs, which causes "thumps", was assumed to be the phase of infection that most severely affected the growth of pigs. Hale *et al.* (1985) showed in experimental studies that digestion and N-balance are affected adversely only during the maturation phase of ascarid infection (day 33 to 37). Accordingly, proper timing of the anthelmintic treatment so that it occurs before the maturation of the roundworms could be expected to produce a detectable improvement in weight gain. To prevent the build-up of mature ascarids, the frequency of treatment should be at least once every 5 weeks.

The aim of this set of trials was to verify the impact of a 5-day treatment regime with flubendazole (Flubenol® Janssen Animal Health) every 5 weeks, which is based on the shortest pre-patent period of *A. suum* and on the available parasitological and zootechnical data concerning fattening pigs being raised under normal conditions for a period of at least 16 months (4 rounds).

## MATERIALS AND METHODS

The selection criteria for the fattening farms were very strict. Only pig farms without clinical problems caused by worm infections and with a low percentage of rejected livers (<15%) were included. Before the start of the new treatment regime, all the fattening farms had a low EPG (Eggs Per Gram) for *Ascaris* and a history of low parasitic hepatitis.

*Farm A* (Belgium, 1,623 pigs): a closed pig farm with a breeding unit of 100 sows (Landrace x Pietrain).

*Farm B* (Belgium 19,454 pigs): a fattening farm with 7 fattening units of approximately 600 fattening pigs each. Before and during the trial, all the piglets came from the same breeding unit with 900 sows.

*Farm C* (The Netherlands 12,880 pigs): in this closed pig farm (IKB certificated), the fattening pigs are supplied by its own breeding unit.

*Farm D* (France 10,158 pigs): a closed pig farm with 900 sows, where the fattening pigs were supplied by its own breeding unit.

### Farm management

No modifications were allowed in the following parameters: management, feed supply, feed supplier, presentation of feeds, drinking water supplies, ventilation techniques and the origin of the piglets. The feeding schedule remained the same for all the piglets during all rounds of the trial period. The pens had a slatted concrete floor. The pigs were allocated randomly to the control group and the different treatment groups. The pigs remained in the same pen throughout the entire fattening period until slaughter weight. They got a specific stamp and were slaughtered in the same slaughterhouse as the control pigs. After each round, when the pigs were taken to the slaughterhouse, all the compartments were cleaned and disinfected and remained empty for 7 days. This procedure was the same before and during the trial conducted.

### Deworming programs

Before the new deworming regime was introduced, fattening farms A, B and C had their own deworming program.

*Farm A*: 5 mg/kg levamisole administered intramuscularly to all piglets at the start of the fattening period.

*Farm B*: Ivomec® premix 0.6% for 7 days and flubendazole medicated feed for 5 days at day 60.

*Farm C*: 7.5 mg/kg levamisole in the drinking water for 1 day every 4 weeks.

*Farm D*: no deworming.

During the trial, medicated feed with 30 ppm flubendazole was given for 5 days every 5 weeks: i.e. at the start, at day 40 and at day 79 during 4 rounds on each of the 4 farms. The medicated feed was always supplied from the same supplier. A feed sample of 500 g was taken during each deworming period at day 3 of the treatment period. The concentration of flubendazole in the feed samples was analyzed by high performance liquid chromatography and UV detection (HPLC-UV) at the certified laboratory SGS Belgium.

### Registration of data

During the trial, all the fattening pigs were observed daily for clinical side effects. The pigs were weighed by group (i.e. by pen) at the start of the fattening period and before slaughter. The following economic parameters were registered and calculated: daily mortality and dropouts, daily weight gain, duration of fattening period and the total feed consumption per round. The results shown in the tables represent the average values of 4 treatment rounds.

Ten mixed fecal samples were taken at random from several pens (minimum 20), before treatment and every 5 weeks during each round. Eggs Per Gram (EPG) were counted in these samples using a flotation technique. The concentration solution used was a saturated salt solution with a density of 1.20 at 20°C (Thienpont D., *et al.* 2003).

In the slaughterhouse, white spots and rejected livers were noted for farms A, B and C. In farm C, the meat quality was registered as well. For farm D, no liver scores could be registered in the slaughterhouse due to the high throughput of the slaughter line.

### Statistical analysis

The statistical analysis was performed on verified and locked databases, using SAS® software, version 9.1.3. All tests on differences between groups were designed as two-tailed tests. For all tests, differences were considered to be statistically significant only if $p \leq 0.05$. The statistical differences found were reported as such. If nothing is mentioned, the differences are considered not to be statistically significant. For the analysis of the percentage liver rejection, the Wilcoxon Mann-Whitney U-test was performed. For average daily weight gain, the t-test was used. The lean meat scores (SEUROP) were studied by means of the Wilcoxon Mann-Whitney U-test.

Mortality and dropouts were analyzed on farm A using the Fisher exact test due to uneven numbers. On the results of farm B, a t-test was performed in view of the high number of data. For the data analysis of farm D, the Wilcoxon-Mann-Whitney U-test was used.

Other comparisons did not reveal statistically significant differences or trends.

## RESULTS

During 4 rounds on 4 different farms, the zootechnical results of 21,721 treated pigs and of 22,394 control pigs, along with historical pretreatment data were compared and statistically analyzed in this large European trial (Table 1).

### Parasitological data

#### EPG counts

In farm A, before treatment, 28.5 to 50% of the mixed samples from the randomly chosen boxes were positive for *A. suum*. At the second sampling 11.1% were positive. From the third sampling on, all the samples were negative and remained so until the day before slaughter.

In Farms B, C and D, the proportion of positive samples before treatment was lower than 5% and was practically nihil after treatment (< 1%). Judged from a qualitative point of view (positive or negative), none of the data on EPG counts revealed any statistically relevant information.

### Liver lesions

In the treated pigs of farm A, considerably less livers condemned for white spots were noted in the treated groups compared to the control group. In the treated group, more pigs had healthy lungs and less lung lesions.

In farm B, the prevalence of parasitic hepatitis was low. In the pre-treatment period, out of the 320 livers evaluated, 300 had no lesions, 10 had only slight lesions and 0.6% were rejected for severe liver lesions. After the 4$^{th}$ round, almost no liver lesions (0.024%) could be seen anymore in the treated groups.

The Wilcoxon-Mann-Whitney U-test revealed a statistically significant reduction ($p = 0.0286$) on farm C (7.8% versus 3.9%) in affected and rejected livers after treatment.

In farm D, the liver lesions were not scored due to the high throughput of the slaughter line (Table 2).

### Daily weight gain and feed conversion

A positive effect on average daily weight gain (ADW) was noted on three different farms. The average daily weight gain was 15.1g to 34.7g better in the

**Table 1. Number of pigs and their body weight at start and at slaughter, and duration of the fattening period.**

| Farm | Group | Number of pigs | Body Weights (kg) At start | Body Weights (kg) At slaughter | Fattening period (days) |
|---|---|---|---|---|---|
| A | Control | 163 | 23.34 | 103.27 | 145.4 |
| | Treated | 1,460 | 23.77 | 106.32 | 143.0 |
| B | Control | 10,893 | 22.67 | 117.50 | 147.7 |
| | Treated | 8,561 | 22.17 | 117.59 | 145.0 |
| C | Control | 5,800 | 25.33 | 111.98 | 121.1 |
| | Treated | 7,080 | 25.24 | 112.69 | 122.4 |
| D | Control | 5,538 | 30.00 | 112.90 | 107.4 |
| | Treated | 4,620 | 30.80 | 116.83 | 109.5 |

**Table 2. Percentage of rejected livers.**

| Farm | Group | Number of pigs | Rejected livers (%) |
|---|---|---|---|
| A | Control | 163 | 8.6 |
| | Treated | 1,460 | 5.6 |
| B | Control | 10,893 | 0.6 |
| | Treated | 8,561 | 0.024 |
| C | Control | 5,800 | 7.8 |
| | Treated | 7,080 | 3.9[a] |

[a] p-value = 0.0286

**Table 3. Average daily weight (ADW) gain (g) and feed conversion ratio (FCR).**

| Farm | Group | Number of pigs | ADW (g) | FCR |
|---|---|---|---|---|
| A | Control | 163 | 549.5 | No Data |
| | Treated | 1,460 | 584.2 | No Data |
| B | Control | 10,893 | 650.1 | 2.962 |
| | Treated | 8,561 | 665.2[b] | 2.954 |
| C | Control | 5,800 | 716.2 | 2.980 |
| | Treated | 7,080 | 715.1 | 2.880 |
| D | Control | 5,538 | 772.0 | 3.047 |
| | Treated | 4,620 | 787.2 | 2.942 |

[b] p-value = 0.0528

**Table 4. Percentage Lean Meat (SEUROP) in Farm C.**

| Parameters | Lean meat % | | p-value* |
|---|---|---|---|
| | Control | Flubendazole | |
| **S** (>60% lean meat) | 11.51 | 9.48 | 0.0144 |
| **E** (55% to 60% lean meat) | 66.73 | 67.36 | 0.7915 |
| **U** (50% to 55% lean meat) | 19.30 | 22.04 | 0.0678 |
| **R** (45% to 50% lean meat) | 0.94 | 0.91 | 0.7286 |
| **O** (40% to 45% lean meat) | 0.04 | 0.01 | 0.4418 |
| **P** (< 40% lean meat) | 0.00 | 0.00 | 1.0000 |
| Remaining | 1.48 | 0.19 | 0.6889 |
| **Total S+E+U** | **97.54** | **98.89** | 0.6415 |

**Table 5. Mortality and dropouts during fattening period.**

| Farm | Group | Number of pigs | Mortality and dropouts (%) |
|---|---|---|---|
| A | Control | 163 | 10.4 |
| | Treated | 1,460 | 8.6 |
| B | Control | 10,893 | 6.0 |
| | Treated | 8,561 | 4.3[a] |
| C | Control | 5,800 | 6.8 |
| | Treated | 7,080 | 6.8 |
| D | Control | 5,538 | 4.6 |
| | Treated | 4,620 | 3.6 |

[a] p-value = 0.0060

treated groups. The difference with the control group was borderline significant in Farm B. In the other farms no statistically significant differences could be found (probably due to the differing management systems and treatment methods and the long time needed to complete the study).

In three farms (B, C, D), the positive trend of a better feed conversion rate (FCR) was noted, although a statistical significance could not be proven. For Farm A, no FCR could be calculated due to the fact that the farm did not use an all-in/all-out management system (Table 3).

## Meat quality

In Farm C, two different criteria for meat quality, i.e. musculature and percentage of lean meat, were evaluated. The combined percentages of the highest categories of meat quality (Types AA and A) were higher in the treated group (89.68%) than in the control group (87.46%). According to the SEUROP classification, the total percentages of the best lean meat classes (S, E, U) was greater in the treated group (98.89%) than in the control group (97.54%). This is a statistically significant difference, for the three best meat classes, and particularly for the S class. The Wilcoxon-Mann-Whitney U-test revealed a significantly (p = 0.0144) higher number of animals in the S class in the control group and a statistical trend (p = 0.0678) for higher number of animals in the U class for the flubendazole group, a fact which results in added economic value for the pig farmer. A tendency to shift production to the more uniform and economically interesting E and U classes was noted (Table 4).

**Mortality and dropouts**

On farm B, the t-test showed significantly (p = 0.0060) lower mortality and dropouts in the flubendazole group. On the other farms, the difference between the treated groups and the controls was statistically not significant (Table 5).

## DISCUSSION

Under field conditions, fattening pigs in modern hygienic units are exposed to low doses of eggs of *A. suum* (Roepstorff *et al.*, 1997). As a consequence, they develop limited immunity and are incapable of preventing "white spots" in the liver. A comparison of liver scores with a gold standard of serial egg counts demonstrated a sensitivity of 96% and a specificity of 24% (Bernando *et al.*, 1990). These findings demonstrate that pigs with an intestinal worm burden almost always have liver lesions, but pigs with liver scars may not have a patent worm load. In practice, this means that EPG counts do not reflect the real significance of ascarid infections on a pig farm. Even low positive *Ascaris* egg counts in the beginning of the fattening period can lead to an explosive increase of infection prevalence later during that period. Therefore, even if fecal examination suggests a very low prevalence of infection, control measures should always be taken from the start of the fattening period onwards, in order to prevent the build-up of a massive infection towards the end of the fattening period. A large part of *Ascaris* infections are not properly treated or are undertreated, because the parasite levels are thought to be either low or zero (Agneessens and Kanora, 2004).

Although the losses due to ascarid lesions are highly variable because of different abattoir costs and the fluctuating market prices of livers, the damage can be assessed at €0.26 per kg to destroy the livers and €0.87 per liver lost (Vercruysse, 2002). To reduce the prevalence of white spots with one single treatment is nearly impossible. Anthelminitic control programs should have a very high efficacy and all new infections need to be prevented throughout the entire fattening period. Any insufficient control system will rather increase the problem of white spots at slaughter.

From various studies, there is ample evidence that a significant reduction in liver condemnation is possible after a long-term strategic deworming with flubendazole (Bakker, 1984; Van Meirhaeghe and Maes, 1996, Kirwan *et al.*, 2004). It was not surprising that significantly less livers condemned for white spots were noted in Farm A, which, due to the high prevalence of *Ascaris* infections before the new treatment regime started, was already using strategic deworming. Even in the other fattening stations, with rather low incidence of parasitic hepatitis, a significant reduction in white spots was obtained through strategic deworming every 5 weeks with flubendazole.

Daily weight gains are mostly not correlated either with the number of white spots or with the number of intestinal worms at slaughter or with the fecal egg counts (Nillson, 1982). However, the ascarids do seem to have an adverse effect on digestion and the absorption of nutrients when they reach maturity (Hale and others, 1985). Research examining the relationship between ascarid load and growth performance indicated that modest growth loss was associated with roundworm load (Bernando *et al.*, 1990). According to Stewart and Hale (1988), growth loss associated with ascariosis can add 5 to 13% to the production cost to market. The two main results of this trial, the positive effect on average daily weight gain of 15.1 to 34.7g and fewer dropouts, both point in the same direction.

In Farm B, the existing worm control program reduced the liver white spots to a very low number. The effect of the extra deworming with the newly adopted treatment regime at day 79 could hardly be better in terms of lowering the prevalence of the parasitic hepatitis. Nevertheless, mortality and dropouts were significantly lower in the groups treated three times with flubendazole.

In Farm C, the control group, i.e. the pre-treatment group over a period of one year, was treated every 4 weeks with a one-day treatment of levamisole in the drinking water. The existing worm control program was unable to prevent the development of white spots in the livers. After the new deworming regime with flubendazole, the number of rejected livers decreased from 7.8% to 3.9%. The zootechnical data such as daily weight gain and meat quality were slightly better in the treated groups. A shift to the more optimal (55 to 60%) lean meat percentage was noted. The influence of parasitic infections on meat quality has not been well studied. But according to Theodoropoulos *et al.* (2004), the meat of pigs infected with *Ascaris, Trichuris* and *Hyostrongylus* was different in some quality characteristics from the meat of pigs not infected with these parasites. Pigs infected with ascarids that were slaughtered at 10 months had increased moisture values compared to pigs not excreting *A. suum* eggs.

Taking into account the fact that the treated group in Farm D started with a higher mean weight and stayed about 2 days longer in the fattening pen, the overall mean body weight was clinically still significantly higher in the flubendazole treated group.

## CONCLUSION

Given the length of time of the study and the difficult field conditions (e.g. different farm management and locations), it is nearly impossible to consistently find values that are significantly statistically different. The statistical differences that were found in this trial, however, clearly indicate that the application of a deworming regime based on the minimum pre-patent period of *A. suum* and applied under normal conditions in hygienic fattening units can ameliorate the prevalence of parasitic hepatitis and the zootechnical performance of fattening pigs.

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