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# Feeding DFMs offers piglets a healthy start

*Supplementing sow feed in late pregnancy with a direct-fed microbial product based on* Bacillus subtilis *spores helps establish beneficial bacteria into the piglet's gut more quickly.*

By **GWENDOLYN JONES***

THE successful rearing of piglets from birth through weaning is an important factor affecting profitability in the swine business.

Direct-fed microbials (DFMs) have been discussed as a tool for use in feeding strategies established to help support the successful rearing of piglets in the preweaning stage.

## Healthy start

While the target for preweaning mortality should be less than 8%, the U.S. PigChamp database records show that in a typical U.S. swine unit, 10.0-12.5% of piglets born alive do not make it to weaning.

Recent studies carried out at Purdue University (Schinckel et al., 2009) showed that even if piglets make it to weaning, they do not necessarily finish on time. Piglets with low weaning weights took longer to achieve target market bodyweight.

Each piglet lost prior to weaning is a major loss in income per sow, and each extra day to market costs at least 10 cents per pig per day. Therefore, managing the health and vitality of suckling piglets to meet growth and survival targets to weaning has a significant effect on the profitability of swine production.

Out of all the diseases that can affect the sucking piglet, scours are the most common and the most important. The main bacterial causes of scours are *Escherichia coli* and clostridia proliferating in the gut of the piglet.

In a Danish study that included 104 different sow herds, it was shown that litters with preweaning scours had a loss of 0.6 more piglets from birth to weaning compared to litters without the occurrence of scours. Furthermore, piglets from litters with preweaning scours had reduced weight gain and were, on average, 2.2 days older when they reached 55 lb. of bodyweight.

However, even without clinical signs of scours, piglets can be unthrifty and have lower weights at weaning. Insufficient colostrum intake and imbalances in the gut microbiota during the early development of piglets may be causes, reducing piglets' immunity and utilization of nutrients and, hence, their vitality and growth.

## Gut gatekeeper

Maintaining a healthy gastrointestinal tract is vital for animal growth and development. A healthy gut allows the maximum amount of nutrients to be absorbed and acts as a barrier against disease. In fact, the gut represents a major component of the immune system.

Furthermore, the gastrointestinal tract of the pig is colonized by an extremely diverse commensal bacterial population of more than 400 bacterial species.

A normally functioning gastrointestinal tract is characterized by a healthy balance between harmless and pathogenic bacteria within this flora. An imbalance in the gut microbiota favoring pathogenic bacteria either during the pig's development or when already matured makes the animal more susceptible to disease and can cause suboptimal production results.

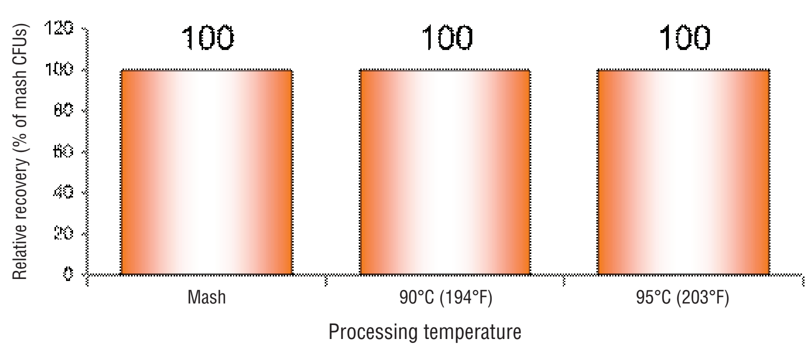
There is a symbiotic relationship between the gut microbiota and the pig. The bacteria benefit from a stable synergistic habitat in the gut and from the energy provided by ingested feed. In turn, the pig benefits from the vitamins and enzymes provided by the bacteria, which help to release nutrients from indigestible carbohydrates in the hindgut.

Furthermore, the bacteria influence intestinal physiology, morphology, mucus secretion, metabolism and immune functions. This is consistent with the observation that germ-free animals have an undeveloped mucosal immune system.

In a healthy gut, the microbiota favors beneficial bacteria, principally lactobacillus and bifidobacterium, which have been shown to help control several pathogenic bacteria, including salmonella, *E. coli* and clostridium.

The exact mechanism for this is still largely unknown, but one hypothesis is that the beneficial bacteria compete with the pathogenic ones for adhesion to common receptors on the intestinal epithelium in a process termed "competitive exclusion" and produce conditions that are unfavorable to the growth of pathogenic bacteria, e.g., a low pH.

**Percentage recovery of *Bacillus subtilis* strains from three tests in feed after conditioning and pelleting**

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## Microbiota development

The *in utero* piglet is sterile, but from the moment the piglet leaves the security of the uterus and enters the birth canal, it becomes exposed to and is colonized by microbes.

Under normal circumstances, the newborn pig rapidly acquires its characteristic gut microbiota through contact with its mother and its birth environment. Colonization of the gut is determined by the relative proportion of different organisms in the piglet's environment and the extent to which the piglet comes into contact with them.

Sucking piglets can ingest large quantities of the sow's feces and bedding material, and the sow's teats can be heavily contaminated with microbes from feces and the environment.

Thus, if the microbiota the sow introduces into the piglet's environment can be modified in a beneficial way, this can exert a beneficial effect on the microbial colonization of the piglet's gut from birth.

Increasing the amount of health-promoting bacteria in the piglet's environment and minimizing the numbers of pathogenic bacteria will help to establish a healthy gut microbiota in the piglet and ensure a lasting healthy start.

## Healthy balance

DFMs are live microorganisms widely recognized for their ability to help establish and maintain a balanced gut microbiota. Feed additives containing DFMs effectively flood the gut with billions of live, beneficial bacteria to help boost the gut's normal microbiota.

By definition, a DFM helps to improve the intestinal microbial balance, with consequential beneficial effects for the host.

DFMs can be distinguished by their origin, between bacteria that naturally occur in the digestive tract, spore-forming bacteria with soil as a natural habitat and yeasts, which do not occur in the digestive tract.

Not all DFMs work in pigs, so the first challenge in creating effective DFM feed additives is to identify those microbial strains that do show beneficial effects. It is equally important to ensure that the DFMs are able to survive feed processing and subsequent storage in order to reach the pig's gut to fulfill their mode of action.

By far, the most stable strains are bacillus spores because they are heat resistant and stay viable during long-term storage. Pelleting tests carried out with a multi-strain *Bacillus subtilis*-based DFM (Figure) have shown that the strains are stable to 95°C (203°F).

DFM preparations may consist of single strains or may contain more than one

### 1. *Bacillus subtilis* counts (colony-forming units [CFU]/g feces) from sows and piglets nursing sows supplemented with a multi-strain *B. subtilis*-based DFM during late gestation and throughout lactation compared to control sows and their piglets (Baker et al., 2008)

| | Lactation day | Control | DFM |
|---|---|---|---|
| Sows | -1 | ND* | $1.1 \times 10^6$ |
| | 14 | ND | $3.7 \times 10^5$ |
| Piglets | 3 | ND | ND |
| | 5 | ND | $6.0 \times 10^3$ |
| | 14 | ND | $1.5 \times 10^4$ |

*ND = DFM bacillus strains not detected.

### 2. Incidence of terminal restriction fragments (T-RFs) differing in the colon between piglets nursing sows supplemented with a multi-strain *B. subtilis*-based DFM versus piglets nursing control sows at day 3 (Baker et al., 2010)

| | -Binary mean[2]- | | | |
|---|---|---|---|---|
| T-RF[1] | Control | DFM | P-value | Putative bacterial identification[3] |
| B423 | 0.47 | 0.95 | 0.01 | *Lactobacillus gasseri*, *Lactobacillus johnsonii* |
| H330 | 0.85 | 1.00 | 0.08 | *Lactobacillus gasseri*, *Lactobacillus johnsonii* |
| M89 | 0.52 | 0.15 | 0.01 | *Flexibacter* sp., *Flavobacterium* sp., *Bacteroides* sp. |
| M96 | 0.71 | 0.40 | 0.04 | *Bacteroides* sp., *Prevotella* sp. |
| M214 | 0.66 | 0.35 | 0.04 | *Clostridium hungatei* |
| M220 | 0.80 | 0.35 | 0.01 | *Clostridium* sp., *Eubacterium* sp. |
| M495 | 0.71 | 0.25 | 0.01 | *E. coli*, *Haemophilus* sp., *Mannheim* sp.; *Pasteurella* sp., *Salmonella* sp. |
| M539 | 0.61 | 0.35 | 0.08 | *Mycoplasma* sp. |
| B387 | 0.76 | 0.40 | 0.02 | *Clostridium ramosum*; Mycoplasma sp.; *Pseudomonas* sp., *Brevibacillus* |
| B394 | 0.76 | 0.45 | 0.04 | *E. coli*, *Pasteurella* sp., *Salmonella* sp. |
| B518 | 0.95 | 0.70 | 0.03 | *Bacteriodes* sp., *Flavobacterium* sp., *Prevatella* sp. |
| H240 | 0.76 | 0.50 | 0.08 | *Eubacterium* sp., *Paenibacillus alvei* |
| H251 | 0.76 | 0.45 | 0.04 | *Clostridium* sp., *Mycoplasma* sp. |

[1]Restriction enzyme, B = BstUI, H = HaeIII, M = MspI and T-RF size (bp).
[2]Mean binary presence of T-RFs in piglets nursing sows supplemented with DFM versus control piglets.
[3]Putative T-RF bacterial identification using Online Microbial Community Analysis software (MiCA3, University of Idaho department of biological sciences; http://mica.ibest.uidaho.edu).

### 3. Incidence of T-RFs differing in the colon between piglets nursing sows supplemented with a multi-strain *B. subtilis*-based DFM versus piglets nursing control sows at day 10 (Baker et al., 2010)

| | -Binary mean- | | | |
|---|---|---|---|---|
| T-RF | Control | DFM | P-value | Putative bacterial identification |
| M280 | 0.57 | 0.93 | 0.02 | *Lactobacillus* sp., *Bifidobacterium* sp., *Eubacterium* sp., *Fusabacterium* sp., *Microbacterium* sp. |
| M569 | 0.35 | 0.68 | 0.07 | *Lactobacillus* sp. |
| B247 | 0.71 | 1.00 | 0.02 | *Enterococcus faecalis*, *Lactobacillus delbrueckii*; *Lactobacillus salivarius* |
| B250 | 0.50 | 0.81 | 0.07 | *Lactobacillus acidophilus*, *Lactobacillus brevis*, *Lactobacillus delbrueckii*, *Lactobacillus plantarum*, *Lactobacillus salivarius* |
| B262 | 0.78 | 1.00 | 0.05 | *Lactobacillus crispatus*, *Lactobacillus fructovorans*, *Lactobacillus sanfranciscenisis*, *Pediococcus acidlactici* |
| B417 | 0.35 | 0.87 | 0.01 | *Lactobacillus alimentarus*, *Lactobacillus bifermentos* |
| B423 | 0.71 | 1.00 | 0.02 | *Lactobacillus gasseri*, *Lactobacillus johnsonii* |
| H279 | 0.78 | 1.00 | 0.05 | *Lactobacillus brevis*, *Lactobacillus delbrueckii*, *Lactobacillus salivarius* |
| H330 | 0.71 | 1.00 | 0.02 | *Lactobacillus gasseri*, *Lactobacillus johnsonii*, *Lactobacillus sakei* |
| H333 | 0.28 | 0.75 | 0.01 | *Lactobacillus sakei*, *Lactobacillus hilgardii* |
| M134 | 0.85 | 0.56 | 0.08 | *Bacillus* sp., *Bifidobacterium* sp., *Mycoplasma* sp., *Paenibacillus* sp. |

strain. The attraction of multiple-strain preparations is that they are active against a wider range of gut conditions and in a wider range of animal species.

## Suckling piglets

Research carried out by Danisco Animal Nutrition showed that when a multi-strain *B. subtilis*-based probiotic product specifically developed for pigs was fed to sows during late pregnancy and throughout lactation, it resulted in bacillus strains being present in the feces of the treated sows and the piglets from treated sows (Table 1), effectively showing successful fecal-oral transfer of the bacillus spores from sow to piglet.

A further study (Baker et al., 2010) evaluated the effect of feeding this combination of *B. subtilis* strains to sows prior to lactation on the gastrointestinal microbiota of neonatal piglets at days 3 and 10 of lactation.

Piglets nursed by sows whose feed had been supplemented with the DFM had a significantly higher incidence of certain lactic acid bacteria in the colon compared to piglets from control sows (Tables 2 and 3).

This second study shows how the developing gastrointestinal microbiota of a neonatal piglet can be influenced by DFM supplementation to the sow.

Finally, Rosener et al. (2009) showed that over a 21-day lactation period, piglet livability was increased in response to the feeding of a multi-strain *B. subtilis*-based DFM to sows during late gestation and lactation.

## Conclusion

The developing gut microbiota in the neonatal piglet plays an important role in the pig's future vitality, its efficient nutrient utilization and its natural ability to resist disease caused by pathogenic bacteria entering the piglet's gastrointestinal tract.

The supplementation of sow feed in late pregnancy with a DFM based on *B. subtilis* spores is an effective means of transferring the beneficial effects of the DFM from the sow to the piglet and helps to establish beneficial bacteria such as lactobacillus in the gut of the piglet more quickly.

## References

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