

Combined effects of garlic and cinnamon, a natural solution to reduce antibiotics use

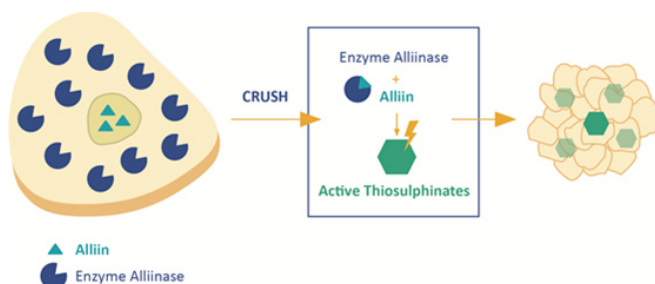
Thanks to a unique technology, Excential Alliin Plus preserves the best of nature to boost animals' gut health. Combining the broad range of benefits attributed to garlic with the powerful essential oil of the cinnamon bark, Excential Alliin Plus' active ingredients have been reported anti-pathogenic, anti-inflammatory and pro-gut flora.

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Selection and stability of the garlic cloves

Garlic's fame in the world of health is most attributed to the chemically-defined garlic derivative allicin, an alkaloid thiosulphinat molecule identified as diallyl-dithiosulfinate. As in all plants, the natural levels of such active compounds may vary depending on the environmental conditions. Selection of thiosulphinat-rich cloves is therefore crucial to the production of Excential Alliin Plus.



Allicin's volatility causes practical and logistic constraints for effective use in animal feed. Nature itself has found the best way to conserve the full effects of garlic active molecules by storing a precursor molecule and an activator but not allicin as such. Activated by the alliinase enzyme, alliin's precursor molecule alliin transforms into allicin when the right conditions are met. While both alliin and alliinase are present in the garlic cloves, they are present in separate compartments. Allicin is formed only when alliin and alliinase get in contact through mastication or processing

of the garlic clove. Thus, preserving the integrity of their compartments by freeze-drying before milling is essential. Without this protection, the most powerful effects of the garlic molecules would easily be lost during storage and processing.

Garlic and cinnamon, an optimal team for multiple targets

Years of research have placed garlic and cinnamon at the top of the anti-pathogenic natural agents. These two plant-derived additives therefore qualify as phytonutrients, or phytochemicals.

Garlic's active antimicrobial agents belong to the thiosulphinates, of which allicin is generally claimed to be responsible for most of these benefits. Research indicates high effectiveness against pathogens, allicin may thus prevent digestive problems caused by, for example, *E. coli*, *Salmonella* and *Rotavirus*. However, providing the full garlic clove also confers effects linked to other sulfur compounds such as diallyl disulphide (DADS), S-allylcysteine (SAC) and diallyl trisulfide (DATS). Recent studies review the roles of phenolic and organosulfur compounds present in whole garlic in relation to anti-pathogenic as well as global health effects (Martins et al., 2016 Food Chemistry). Therapeutic uses and pharmacological properties of garlic are reported for protection against viral, bacterial, fungal, parasitic pathogens to support cardiovascular and immune functions.

Cinnamon oil, the second component of Excential Alliin Plus, contains agents that are reported to have gut health promoting properties. The predominant agent, cinnamaldehyde, accounts for around 80% of the oil's composition. With a simple phenolic

structure, cinnamaldehyde seems to feature a wide array of activities against countless bacteria, yeast and fungi. Various studies report that cinnamaldehyde actively mitigate *E. coli*, *Salmonella enteritidis*, *Clostridium perfringens*, and *Aspergillus flavus*. In addition to reducing the population of pathogenic agents, cinnamaldehyde stimulates intestinal secretions, improves absorptive capacity and modulates inflammation.

The array of garlic and cinnamon's functions together can serve as alternative solution to growth promoting antibiotics as they affect the microbial populations and host responses, specifically anti-inflammatory properties. Although the mechanisms through which dietary antibiotics exert their growth promoting effects remain to be established, they are more and more suggested to improve growth performance through an anti-inflammatory effect directed toward the intestinal epithelium (Deepthi Gadde et al., 2018 Scientific Reports). This would also explain why growth promoting effects remain although resistance towards these same antibiotics rises. Growth promoting effects relying on the anti-inflammatory capacity of antibiotics like virginiamycin or bacitracin might well be replaced by a strong phytochemical solution like Excential Alliin Plus.

Garlic and cinnamon, parasites' nightmare

Garlic on its own may prevent or mitigate upon onset, a diversity of parasitic diseases in all animal categories. By adding cinnamon extracts, Alliin Plus widens this range of applications.

In aquaculture, where garlic is already used against the white faeces syndrome in shrimp caused by the combination of gregarines parasite and high levels of *Vibrio spp.*, Excential Alliin Plus is applied to deter sea lice in aqua populations including cobia fish. Other species can benefit from the properties that comprise of Excential Alliin Plus.

For example, in ruminants Excential Alliin Plus has been most useful in the diet of young calves suffering from diarrhoea and *Cryptosporidium*.

Excential Alliin Plus used in swine was tested against *A. pleuromoniae* induced coughing and supports performance.

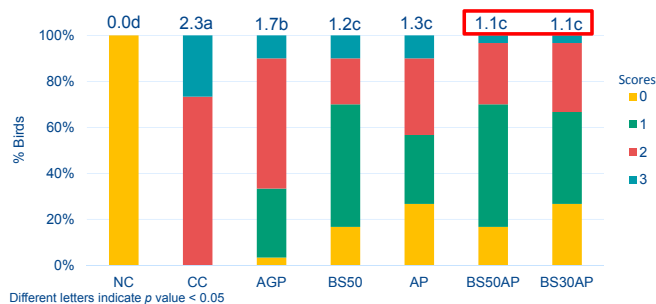
Finally, for poultry application both garlic and cinnamon have been reported to exterminate adult and juvenile red mites and their eggs. Additionally, Excential Alliin Plus may lower *Eimeria* counts responsible for coccidiosis and an indispensable factor for necrotic enteritis in chickens and may be used as a food safety initiative to reduce *Salmonella* populations prior to processing.

Supporting probiotic additives to lower necrotic enteritis

In line with the worldwide trend to reduce growth promoting antibiotics and therapeutic antibiotic treatments, Excential Alliin Plus has earned its place within global 'alternative to antibiotic' strategies. Such strategies commonly champion the usage of probiotics as highly effective. Probiotics are defined as live microorganisms that have direct modulatory effects on the gut microflora. A very common example of feed additive probiotic is *Bacillus subtilis*.

Broiler chicken are fast growers and their short life span restricts the usage of sustainable solutions such as vaccinations. In this context, prevention and reducing onset of coccidiosis and *Eimeria* pre-

NE Lesion Scores. Y axis include the proportion of birds which either received a lesion score of 0, 1, 2 or 3 and the averages are depicted on top. 0 = no lesions and 3 = severe lesions. The control models (Negative Control vs Clostridium Control) depict that NE lesions were presented as moderate to severe. All birds treated (Antibiotic Growth Promotor, Bacillus subtilis C-3102 at 50 ppm, Alliin Plus at 450 ppm or the combination of these 2) presented less severe lesions. Distribution of the lesions is crucial. The highlighted combination of Alliin Plus with either BS at 50 or 30 ppm had over 2/3 of the birds scoring 0 or 1.



Different letters indicate *p* value < 0.05

disposed necrotic enteritis (NE) can be achieved with coccidiostats, a specific category of antibiotic-like pharmaceuticals. Occurrence of NE is tightly connected to the presence of asymptomatic coccidiosis due to the *Eimeria* parasites. However, NE onset will only be triggered when *Clostridium perfringens* bacterium co-infects the bird's gut. In this context, the use of *B. subtilis* as a gut flora stabilizer may prevent the development of *C. perfringens* in the gut.

As feed additives do not claim to compete with pharmaceutical solutions, combining complementary feed solutions is a well-established alternative. Excential Alliin Plus combines anti-pathogenic and anti-parasitic effects, likely to support those of the probiotic *B. subtilis*. In this context, a controlled study organised by an independent university tested the combination of *B. subtilis* with Alliin Plus. Low inclusion level of the probiotic (30 g/tonne of feed) was combined with Excential Alliin Plus (450 g/tonne of feed) in a mash feed. As shown in Table 1, this combination provided better protection against macroscopic gut lesions observed during NE, than the high dose of probiotic alone at a higher dose (50 g/tonne of feed). Also, broiler chickens that received Excential Alliin Plus alone were as well protected against early onset of NE as the birds receiving the antibiotic treatment. Protecting the broilers' gut from NE-induced damages positively impacted the digestion performance of the birds as measured by improvement of the feed conversion ratio (Table 1).

Table 1: FCR. The control models (Negative Control vs Clostridium Control) depict that NE had high impact on FCR. Birds treated with Antibiotic Growth Promotor, Bacillus subtilis C-3102 (BS) at 50 ppm, or Alliin Plus at 450 ppm had better FCR than CC. This improvement was consistently observed with the combination BS and Alliin Plus, as highlighted (in red). This was regardless of BS dosage: 50 or 30 ppm, and it was observed at all periods. However, when looking at the period 0-21 days which includes the healthy period of the birds, only the combination reached statistical significance (see in bold).

Treatments	0-21		14-21		14-28	
	Prior to <i>C. perfringens</i>	D14 <i>Eimeria</i> challenge	Including challenge with <i>C. perfringens</i>			
NC	1.336 c	1.404 f	1.392 e			
CC	1.926 a	3.154 a	2.955 a			
AGP	1.827 ab	2.628 bc	2.710 abc			
BS50	1.769 b	2.440 cd	2.386 d			
AP	1.816 ab	2.691 b	2.745 ab			
BS50AP	1.752 b	2.206 e	2.142 d	-95 pts	-81 pts	-17 pts
BS30AP	1.690 b	2.469 cd	2.451 bcd	-67 pts	-50 pts	-24 pts

Different letters indicate *p* value < 0.05

NC non-challenged control CC challenged control
BS Bacillus subtilis AP Alliin Plus

Summary

In Excential Alliin Plus, garlic and cinnamon team up to replace antibiotics for a better gut health. Backed by an extensive number of trials, Excential Alliin Plus performs its highly beneficial effects in specific dosages on all animal species. The strong phytochemical feed additive Excential Alliin Plus appears to be supportive of other gut health solutions like probiotics, all working together in the quest of limiting the overuse of antibiotics and coccidiostats.