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Phytogenic ingredients in the spotlight:

Ginger – Not just an Asian culinary spice

Last time, we presented turmeric, the ginger look-alike power plant, to you. So, now it's time to dedicate ourselves to the great plant, that does not only look like ginger, but also **is** ginger.
Far beyond its role as a spice, ginger has a long history in human nutrition and wellbeing. Above, it has also found its unresting way into animal nutrition. **Sounds interesting? So it is.**

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Ever had Asian cuisine? Then you've likely experienced ginger in some form or other, though ginger is not only exclusive to Asian dishes. **And where most would see just a classic culinary root, science has found a goldmine of health potential.** Throughout history, encounters with ginger through discovery and trade beyond the Eastern world have delighted plenty of cultures with its uniqueness and zest. Many countries might even consider it a staple or commonplace spice for every kitchen cabinet, though it's also popular in candies, sodas, and much more around the globe. However, its **pungent, spicy, and warming flavors** will always have a distinctly Asian identity.

In a world where we must rapidly seek **creative low-energy and healthier solutions** to our global economy - with agriculture as a huge target - Look under the surface of its culinary appeal, and you'll find hidden within every ginger root not only a delicious seasoning, but health benefits aplenty**. Ginger has a rich history as medicine in herbalist, folk, and traditional healing practices.**

With this of enormous phytogenic potential, health-boosting substances from ginger are already being researched and manufactured into modern medicines for humans. Such useful ancient knowledge of ginger is also transformed into immense agricultural potential today as a more natural, healthier alternative to antibiotics and other growth promoters**. So it's only a matter of time before ginger applications are used and applied for livestock health in agriculture around the globe.**

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What is ginger?

Ginger goes by the scientific name *Zingiber officinale* Rosc**. It falls in the plant family Zingiberaceae, a family named for ginger itself, but which also includes other popular Asian spices like turmeric and cardamom.** Galangal, a common ingredient in Southeast Asian cuisines, is also in the same botanical family as ginger. **Though ginger is often called a root, the commonly used parts of ginger are technically actually a rhizome. Rhizomes are modified underground stems that act much like roots.**

By the way, the current name “ginger” originates from the Middle English *gingivere* and dates back over 3000 years to the Sanskrit word *srngaveram,* which means “horn root” - according to its appearance.

Origins

Interestingly, the origins of ginger are uncertain, though it seems as if it is native to Southeast Asia, explaining its strong presence in Asian cuisines from Korean, Japanese, and Chinese to Vietnamese, Thai, and Indonesian.

It is native to tropical and sub-tropical climates in these areas, though can be hardy in some temperate zones, too, with some protection. From the live ginger rhizome plant grows thinner, more fibrous true roots that spread deep into the earth to bring up nutrients. The top of a ginger rhizome erupts in a tall, spear-like stalk above ground with slender, bamboo-like leaves. **The rhizome, which is the horizontal stem from which the roots grow, has been the most popular plant part in food and medicine as it contains the most bioactive compounds.**

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Though its flavors alone are an alluring addition to many dishes, ginger was just as widely used medicinally as it was culinarily through the ages. The root was chewed for **digestive upsets, coughs, motion sickness, nausea, morning sickness during pregnancy, colds, flu, sore throats, gastrointestinal infections, female health complaints, and much more.**

A tasty and easily likeable herbal root, ginger spread around the world to other countries and regions to be enjoyed as food and medicine. However, its presence everywhere will always be associated with the Far East. **Ginger is also an important healing food and herb in Ayurveda and traditional chinese medicine, the healing herbalist traditions of India and China,** for warming what are considered “cold” afflictions like rheumatism.

Ginger is "generally recognized as safe" by the U.S. Food and Drug Administration (FDA) for humans and animals. However, its modes of action are not completely exploited yet. Therefore, it should be used with caution for therapeutic purposes (Wilkinson, 2000a). The importance of careful scientific research regarding the safety and efficacy of potential therapeutic plant remedies, but also with respect to prescribing risks and benefits of herbal medicine, has been pointed out repeatedly (Barrett, Kiefer, and Rabago 1999; Ness, Sherman, and Pan 1999; Talalay and Talalay 2001).

In humans, a contraindication is given with ginger, if patients take anticoagulant drugs, suffer from blood coagulation disorders or gallstones (German Commission E. Monograph, 1988). Due to its ability to inhibit thromboxane synthase and act as a prostacyclin agonist (Backon, 1991), ginger may have an influence on bleeding times and immunologic parameters.

Active substances

The scope of ginger goes far beyond its great popularity as a spice for refining tasty foods. Its good and world-famous reputation is based not least on its use as a medicinal plant for thousands of years, treating a wide variety of diseases.

But what is it about ginger that makes it such a great offering for health? This can be owed to its many active compounds and metabolites - at least 115, that have been identified by thorough analytical processes - mostly volatile oils. **These include zingiberene, phenylalkylketones, and vanillyl ketones (which include gingerols, shogaols, and zingirones), borneol, citral, and more.**

Gingerol

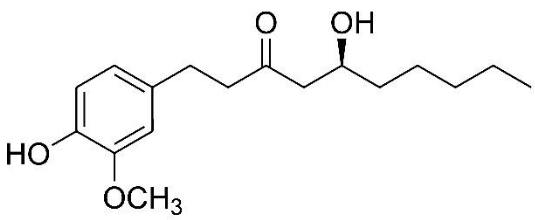

Figure 1. Structural formula of gingerol, one of the active compounds in ginger. ©GettyImages

There are many different types of **gingerols** and **shogaols** that have received attention: **including 6-gingerol, 8-gingerol, 10-gingerol, 6-shogaol, 8-shogaol, 10-shogaol, zingerone, and more.**

Of all these, the most studied substance are **gingerol and shogaol**, especially [6]-gingerol and [6]-shogaol, which seem to be responsible for the bulk of ginger's health properties.

Fresh ginger mainly contains gingerols, which are found only slightly reduced in dry ginger, whereas shogaols, the major gingerol dehydration products, are more present in dry ginger (Jolad et al., 2008).

Ginger and its active compounds can be found in many preparations ranging from over-the-counter pills (such as for motion sickness, which is most popular) to supplements, tinctures, extracts, essential oils, chews, candies, cough drops, and a few other forms. Ginger ale (made with real ginger) can serve its own medicinal purposes in a pinch, too.

Zingibain - the meat tenderizer

Enzymes are important factors regarding the taste of meat: Proteolysis and lipolysis (degradation of proteins and fats) are important enzyme-catalyzed reactions that contribute to the taste of meat by participating in the formation of taste precursors. **Additionally, the tenderness of meat is an essential factor when it comes to meat quality and consumer satisfaction** (Miller et al., 1995). Enzymes also play a decisive role in the tenderness of meat: So-called proteases are responsible for the disintegration of the structural components (i.e. myofibrils, muscle cell membranes and connective tissue) in muscle meat, which increases the tenderness of the meat.

Did you know that adding fresh or dried ginger to meat also increases the tenderness of the meat during cooking? The reason is the cysteine protease zingibain, which is found in ginger rhizomes. **The tenderness of meat is due to the fact that zingibain, through its high proteolytic and collagenolytic activity, catalyses (i.e. promotes) the decomposition of important muscle proteins and collagens in meat, especially actomyosin and type I collagen found in muscle joints** (Lee et al., 1986).

Similar proteases can also be found in other plants, e.g. papain from papaya, bromelain from pineapple or actinidine from the kiwi fruit. **However, zingibain shows some advantages: it has a higher proteolytic activity compared to papain and zingibain is in fact the only catalogued plant protease with collagenolytic activity** (Kim et al., 2007).

For example, one study found that buffalo meat marinated with 3% w/v ginger extract had, among other things, a more desirable taste, water holding capacity, collagen solubility and shear force values than the control samples treated with ginger extract in lower or higher levels (Naveena and Mendiratta, 2004).

Ginger and it’s anti-inflammatory mode of action

Especially in the cold season some of us drink a lot of ginger tea at Delacon. After all, **ginger tea is supposed to help the body in its recovery**. But what's the point of the claim attributed to ginger: its alleged ability to relieve inflammation, swelling and pain (Bode and Dong, 2011)?

If pathogens or foreign substances penetrate our body, the innate immune system provides an initial barrier by activating various processes, including the initiation of inflammatory processes**. Inflammation is an immunological process involving different types of signal molecules such as cytokines**. The aim of this biological process is to react to foreign substances or injuries in order to eliminate them. **However, chronic inflammation can damage the health and growth of animals. Non-steroidal anti-inflammatory drugs are usually used to treat acute and chronic inflammation**. Ginger and its ingredients also fall under the classification of non-steroidal anti-inflammatory drugs used as a traditional remedy. But how exactly does ginger manage to inhibit inflammation?

Researchers have put forward several hypotheses: **According to Srivastava and Mustafa (1992), the anti-inflammatory effect of ginger is based on its ability to inhibit prostaglandin and leukotriene biosynthesis, i.e. the formation of specific inflammatory mediators.** In more detail it was shown, that gingerol has the ability to inhibit arachidonate-5-lipoxygenase, an enzyme required for the biosynthesis of leukotriene (Kiuchi et al. 1992). **Leukotriene antagonists are also used to treat allergic rhinitis and asthma. In addition, [8]-gingerol, but not the derivative [6]-gingerol, has been shown to inhibit the expression of cyclooxygenase-2 (COX-2).** This enzyme is induced during an inflammatory reaction and increases the formation of prostaglandins (Nurtjahja-Tjendraputra et al., 2003). Inhibition of cyclooxygenase has an anti-inflammatory (antiphlogistic) effect as well as an analgesic (pain-relieving) and antipyretic (fever-reducing) effect. **Frondoza et al. (2004) again report that ginger extract suppresses the activation of the tumor necrosis factor α (TNF- α) and the expression of COX-2 in the human joint mucosa - but whether these biochemical processes can also be transferred to our farm animals needs to be examined.** In any case, proinflammatory cytokines such as TNF-α, which are mainly secreted by macrophages, play an important in inflammatory processes (Bode and Dong, 2011).

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Ginger and its antioxidative effects

In the case of persistent stress, e.g. during hot spells or too high stocking density, there is a disproportionate formation of intermediate products of the metabolism, which are known as free radicals - mainly as reactive oxygen species (ROS). These ROS are constantly formed in the mitochondria during oxidative metabolism. **However, if the amount of ROS exceeds the antioxidative capacity, oxidative stress can occur. Oxidative stress causes damage to biological macromolecules, such as nucleic acids, membrane lipids and proteins, and disturbances of normal metabolism.**

Did you know?

Ginger root contains a very high level (about 3.85 mmol/100g) of total antioxidants. This value is only exceeded by pomegranate and some berry species (Halvorsen et al., 2002).

An indicator for measuring oxidative stress is the concentration of malondialdehyde in the blood, which is a product of lipid peroxidation. Higher levels of malondialdehyde correlate with higher oxidative stress. **The main protection of the organism against oxidative stress is the production of antioxidant enzymes. And it seems that ginger supports the body exactly on this topic**. Reports in rats suggest that feeding rats with ginger reduces lipid peroxidation and supports the activity of the body's own antioxidant enzymes (including superoxide dismutase and glutathione peroxidase). **In addition, Ahmed et al (2008) reported that consumption of ginger reduces lipid peroxidation and normalizes the activities of**

superoxide dismutase and catalase and glutathione and glutathione peroxidase, glutathione reductase and glutathione S-transferase in rats. Consequently, these effects lead to a reduction in oxidative stress, which in turn has been shown in lower malondialdehyde concentrations (Ahmed et al., 2008; Uz et al., 2009).

Karunakaran et al. (2017) also demonstrated that aqueous extracts of ginger significantly **reduced carrageenan-induced inflammation in rat paws and associated edema**. Carrageenan is a potent chemical used to release inflammatory and proinflammatory mediators (prostaglandins, leukotrienes, histamine, bradykinin, TNF-α etc.). Not only in this study it was shown that **ginger is able to reduce inflammation in tissue**: Choi et al. (2013) also tested the anti-inflammatory effects of dried ginger in mice treated with lipopolysaccharides (LPS). They found that it reduces the pathological inflammatory symptoms in the liver and the concentration of circulating pro-inflammatory cytokines IFN-y and IL-6. **The activation of NfκB was also inhibited, as was the expression of COX-2.**

What does this mean in terms of inflammation?

IFN-y and IL-6 belong to the cytokines that regulate the inflammatory reaction of the organism and NfκB is of great importance for the regulation of the immune response, cell proliferation and cell death. The activation of NFκB is considered critical for the development of inflammation. COX-2 is particularly expressed in damaged or inflamed tissues, where it forms prostaglandins that enhance or maintain an inflammatory response. **Therefore, a low concentration of these markers apparently represents a low level of inflammatory processes with which the organism has to deal, hence saving energy and not being that susceptible for further diseases.**

The power of ginger against respiratory disorders

The **anti-inflammatory effect of ginger** can do more: it also **offers support in the treatment of asthma**, which is a long-term inflammatory disease of the respiratory tract (Townsend et al., 2013, 2014). Ginger and its bioactive compounds have been shown in several studies to have bronchodilating activity and antihyperactivity (Mangprayool et al., 2013). Experiments with humans showed that especially [6]- and [8]-gingerol, as well as the active substance [6]-shogaol of ginger caused a significant and rapid relaxation of the isolated smooth muscles of the respiratory tract (Townsend et al., 2013).


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In addition, Khan et al. (2015) showed that dietary intake of ginger in ovalbumin-induced allergic asthma in mice improved allergic asthma by **reducing allergic respiratory inflammation** and suppressing Th2-mediated immune responses. In addition, the water-extracted polysaccharides of ginger have been shown to **reduce the frequency of coughing** caused by citric acid in guinea pigs (Bera et al., 2016). Mangprayool et al. (2013) could show that ginger oil and its bioactive compounds, including citral and eucalyptol, inhibited carbachol-induced contraction of tracheal function in rats. These results suggest that ginger and its bioactive compounds, including [6]-shogaol, [6]-gingerol and [8]-gingerol, citral and eucalyptol, have **protective properties against respiratory diseases**. At the very least, ginger appears to strengthen the respiratory tract by **inducing smooth muscle relaxation** and **reducing inflammation** (Mao et al., 2019).

Influence of ginger on the gastrointestinal tract

Enteric bacteria like enterotoxin producing *Escherichia coli* (ETEC), *Vibrio cholera*, *Campylobacter* spp., *Salmonella typhi*, or *Shigella flexneri* are a global problem as they can cause major health concerns. Especially diarrhea is often associated with these pathogens. One of the main reasons for their pathogenicity is the production of toxins, for example cholera toxin from *V. cholera* or heat-labile enterotoxin from *E. coli*. These toxins cause damage in the intestinal tract by binding to cell-surface receptors on the intestinal epithelial cells and cause a disturbance in the fluid balance of the body, which results in diarrhea. It is known for example, that the GM1 ganglioside is the target for enterotoxins in the intestine. In a study with mice, ginger blocked the binding of heat-labile enterotoxin to this receptor. This led to an inhibition of fluid accumulation in the closed ileal loops of the animals (Chen et al.,2007). The authors of this study suggest, that zingerone could be responsible for this **antidiarrheal effect** of ginger. Ginger is also effective by reducing colonization of epithelial cells by intestinal pathogens (e.g. enteropathogenic *E. coli*, enteroinvasive *E. coli*) and is also involved in the inhibition of production of cholera toxins (Daswani et al. 2010). Besides bacterial pathogens, ginger has demonstrated **anthelmintic effects** in preclinical studies against human *Ascaris lumbricoldes* (Kalesaraj, 1974), Anisakis larvae (Goto et al., 1990) and *Haemochus contortusa*, which is a pathogenic ruminant nematode (Iqbal et al.,2001). Ginger also provided **anthelmintic activity** in sheep, thus justifying the age-old traditional use of this plant in helminth infestation (Iqbal et al., 2006). However, ginger is not a “golden bullet” capable to deal with all sorts of problems. For example in the already mentioned *in vitro* study of Daswani et al. (2010), entry of the simian rotavirus S11 into MA-104 cells and the viability of *Giardia lamblia* trophozoites were not affected by a decoction of ginger at all. And although ginger has repeatedly demonstrated its **antibacterial effect** on sensitive and drug-resistant bacteria (Khan et al., 2010; Mascolo et al. 1989; Thongson et al.,2005) as well as its essential oil being effective in certain pathogens (Friedman et al., 2002), it also shows ineffective results, like in a study with strains of enteropathogenic *E. coli, V. cholerae*, and *S. flexneri* (Daswani et al., 2010).

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Therefore it can be concluded that ginger and its compounds can be useful against a range but not all bacterial, viral and parasitic problems. However, due to possible selective influence it may **beneficially influences the gastrointestinal ecosystem through inhibition of microbial pathogens.**

In addition to gingers effects on the intestinal microbiota, it can also affect intestinal morphology and function. When ginger (0.05%) was being fed to Wistar rats over a period of 8 weeks, it could increase the fluidity of the brush border membrane in the jejunal and ileal regions by decreasing the cholesterol-phospholipid ratio. The microvilli length and perimeter were increased, resulting in a larger absorptive surface, which may be co-responsible for the beneficial effects (Prakash and Srinivasan, 2010a). According to Mekuriya and Mekibib (2018), ginger also **helps to improve the absorption of essential nutrients.** Ginger also showed effects on the **contraction** and **motility** of the **reticulum and rumen** in ruminants' studies. Results of an in vivo study demonstrated that hydroalcoholic extract of ginger (containing spasmogenic and spasmolytic constituents) may have a **stimulant effect on reticulorumen motility** in a 40mg/kg concentration (Mamaghani et al., 2013). Biswas et al. (2017) recently demonstrated the **ameliorative effect** of ginger powder against experimentally induced arsenic toxicity in calves. This reveals a potential of ginger to support the body against some forms of intoxication and improve resilience against damage caused by these toxins.

Conclusion

The multitude of beneficial effects observed in studies using ginger demonstrate the highly interesting potential of phytogenics. They can be added to a healthy diet for humans and animals. In livestock production feeding of phytogenic feed additives that include many precious bioactive compounds from plants may contribute to reduce the use of antimicrobial growth promoters such as antibiotics and zinc oxide. This would greatly add to protect the environment and reduce the risk of antibiotic resistance development.

Our message for you: whenever colds are the order of the day, it´s time to resort to herbal helpers that can support your immune system in a natural way...Ever tried **ginger syrup**? No? **Then it´s high time!!**

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