Research Article

Recipe development for healthy sausages with medical plants

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Abstract

Because nutrition based cardiovascular or gastrointestinal diseases, hypertension, diabetes and cancer are increasing in industrial and well developed countries, possibility's to prevent these disorders or to relive the sequelaes are searched. One chance is the production of healthier or functional food. The use of medical plants with health promoting effects are known from traditional medicine, but until know they weren't used in health enhancing amounts in foods, especially in processed meat products.

The main objectives of the development were the identification of medical plants with a scientifically proven preventive effect against gastrointestinal diseases and the combination of them in an effective quantity for the use in emulsion-type sausages. Simultaneously, the combination with all known health promoting measures like fat or salt reduction or the use of plant additives is intended.

Finally, 4 cooked sausages recipes with medical plant combinations were developed and remarkable new sensorial properties in terms of appearance, odour and taste were created. As an additional result, the nutritionally value of the sausages was increased by reducing sodium about 25% by the use of replacer Pansalz® and by increasing the meat protein amount, which is free from connective tissue protein, from 80 to 90% by the substitution of animal fat with vegetable oil, also in 100% exchange of pork meat for turkey meat. Therefore, the fat content in the sausages was reduced from 30 to 20%. The developed sausage recipes are applied in practice. Several consumers' preference tests have shown a great products popularity. Practical applications: Based on a pool of 13 different medical plants with a scientifically proven preventive effect (with a positive monography) against gastrointestinal diseases, 4 sausages recipes with medical plant combinations were developed stepwise and the necessary overall recommended daily intake (RDI) was calculated per 100 g sausages. Traditional spices weren't used. The biggest challenges were to ensure the proven preventive effect of the plants as well the sensorial acceptance of the cooked sausages. In addition, the changes of meat batter properties by reducing the sodium and fat content, also the use of oil and poultry meat had to be observed.

Abbreviations:

AFC - Aniseed-Fennel-Caraway	DCM - Dill-Coriander-Melissa
CCC - Coriander-Caraway-Cardamom	DLG - Deutsche Landwirtschafts-Gesellschaft (German: German Agricultural Society)
CCG - Coriander-Curcuma-Ginger	RDI - recommended daily in-take

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Introduction

Chronic disorders like cardiovascular and gastrointestinal diseases, hypertension, diabetes and colon cancer increased in industrial and well developed countries. Epidemiological studies shown a relationship between the development of some diseases with the consumption, also of processed meat products (McAfee et al. 2010), caused by the content of fat, saturated fatty acids, cholesterol, salt, nitrite or lipid oxidation products and the calorific value. But as part of a balanced diet, the contained proteins, essential amino acids, vitamins and minerals provides nutrition and health protection. The fact, that diet is one of the most important factor that influence healthiness and wellbeing, has been leaded to changes of nutrition habits. The consumers take care evermore on healthier or functional food with preventive effects against diseases and for enhanced wellbeing, in addition to their nutritional value. Currently, healthy or functional processed meat products are limited and oriented on cardiovascular diseases, hypertension and diabetes either by e. g. reducing fat or sodium content, increasing poultry meat amount or using plant oil (Toldrá and Reig 2011; Jongberg et al. 2013; Hygreeva et al. 2014). To prevent gastrointestinal diseases and cancer dietary fibres or probiotics are used or nitride content is reduced in these meat products too. Medical plants contain phytochemicals like polyphenols, flavonoids, phenolic diterpenes and tannins which caused antioxidant, antimicrobial, also anti-inflammatory and/or anticancer effects (Mofleh 2010; Smith-Hall et al. 2012; Ahn 2017). Therefore, since ancient times medical plants are still used in traditional therapy for a number of diseases. In 2002 more than 50,000 medicinal plants worldwide were used (Schipmann et al. 2005). Nowadays, experimental studies and few clinical trials confirmed effects on various disorders. However, the meat industry in Europe use the potential of medical plants only for retarding lipid oxidation-induced food deteriorations, inhibiting the growth of microorganisms and improving flavour, also colour stability of products (McCarthy et al. 2001; Zhang et al. 2010). The objectives of the cooked sausage recipe development were the identification of medical plants with a scientifically proven preventive effect against gastrointestinal diseases like stomach and gut disorders and the combination of them in an effective quantity for the use in emulsion-type sausages. The recipe development includes the combination of all known measures like sodium or fat reduction or only use of poultry meat or plant oil to produce healthy or functional sausages. Traditional spices shouldn't be used.

Materials and Methods

Medical plants. The World Health Organisation has been established traditional medicine policies and has been published conventional medicine guidelines and a series of widely used herbal monographs and others like the European Medicine Agency's with the Committee on Herbal Medicine Products, the European Scientific Cooperation on Phytotherapy and the Commission E of the German Federal Institute for Drugs and Medical Devices follows (Bäumler 2007; Cravotto et al. 2010; Singh 2016). The impact of medical plants that can resolve gastrointestinal diseases like stomach and gut disorders is caused by their e. g. excitosecretory, flatulence dissolved, antispasmodic, sedative and anti-inflammatory effects. On this basis, an intensive literature review at the described sources is realized and possible medical plants with the recommended plant parts were detected. Then, selection criteria were used to lower the number of listed plants:

(1) they have to have a positive monography; this means the benefit prevails the risk; by minimum of one of the sources,

(2) a single or minimum or maximum RDI (recommended daily intake) is declared, because it's the necessary for sausages intake calculation,

(3) they are used as dried plant for tea preparation, because the produced sausages are typically boiled up to 95°C,

(4) heir sensory properties in colour, odour and taste are described as pleasant and

(5) if it's possible, the plants should be well known by German consumers to facilitate the market launch.

A further selection step for the collected medical plants has been based on a sensory evaluation of each plant by a panel. The most pleasant medical plants in flavour, texture and colour were combined to create varying combinations. To guarantee the RDI per 100 g of sausages consumption, the single RDI for each plant has to be converted on base of the sensory tested ratio and the sum of the daily intake in the combination for the desired sausage intake per day. The most flavour-, texture- and colour-pleasant medical plant combinations for the transfer into production of cooked sausages with healthier meat batter recipe were also selected by a professional sensorial evaluation.

Sensory evaluation. A Simple Descriptive Sensory Test by subjective expert opinions (DIN 10975) was used, because descriptive tests involve the sample specific detection (discrimination) and description of qualitative attributes (external appearance, appearance, composition and colour, flavour (odour and taste), texture/consistency). Then sensory properties are quantified in order to facilitate the description of the perceived sensory sample properties. The trained panel included 5 scientists. Each test provided a slice of bread and purified or bubble water to neutralize the taste in the mouth. All selected medical plants with the chosen parts were tested separately for different forms in water and neutral flavoured oil. This is necessary, because sausages are rich in water and fat and the plant ingredients are water and/or oil soluble, also the dried plants are more or less able to absorb water and induced maybe a softer texture. For sensory evaluation, 1 g of medical plant and 15 ml hot water (95°C, to simulate the boiling process) or sunflower oil (23°C) were mixed and after 24 hours of soaking (this is also happened in sausages) at room temperature samples was evaluated. The created medical plant combinations were tested with the same procedure.

The produced cooked sausages were additionally evaluated objectively by the 5-Point-Test-Schedule

for Cooked sausages from the DLG (DLG 2006). The finally 4 developed healthier sausages with medical plant combinations in the new meat batter recipe were also evaluated by 2 big consumer's sensory tests by Questionnaire Method. The questions included selected taste attributes (levels of: pleasantness, spiciness, saltiness, herbaceous sensation), the willing to buy and the gender, also age. The tests were performed in order to find out the general acceptance and preferences for the developed sausages, also to work out points for recipe optimisations. They helped also to generate a big data pool for marked launch strategies. A thin slice of each combination was tested at room temperature. The consumers don't know the medical plant per tested combination. The used combinations are coded for the test as follows:

(1) Aniseed-Fennel-Caraway: "AFC",

(2) Dill-Coriander-Melissa: "DCM",

(3) Coriander-Curcuma-Ginger: "CCG" and

(4) Coriander-Caraway-Cardamom: "CCC".

Sausage production and recipe development. Germans most consumed processed meat products are emulsified-type cooked sausages. Therefore, this type of sausage was selected for the development of healthier sausages. The produced cooked sausage was "Lyoner", a very common one in Germany. In Germany, meat for sausage production can be optional classified in classes by the muscle, fat and connective tissue amount on base of the GEHA catalogue standards (Buckenhüskes et al. 2001). The pork meat (50% GEHA S II, shoulder and leg, ≤ 5% fat; 20% GEHA S III, leg, ≤ 7-10% fat) and pork fat (30% GEHA S VI, jowl) for conventional meat batter recipe was minced on 3 mm and cooled to 4°C. For fine comminution and emulsification, a 500-ml kitchen chopper (laboratory scale) was used. The minced meat, the nitrite curing salt (1.8%; 0.4-0.5% nitrite inside), the auxiliary agent for chopping (0.3%, diphosphates and citrate), also 1/3 of the crushed ice (20%) were put in the bowl and chopped at 1,800 rpm for 30 seconds ("dry chopping"). Then, all minced fat and the rest crushed ice was added and chopped at 2,500 rpm. If the meat batter temperature

reached 12°C, the chopping process was stopped. The final meat batter was filled into conventional artificial casings for cooked sausages with a calibre of 60 mm and was then hot smoked by friction smoke at 55°C for 30 minutes and boiled at 75-78°C with water or steam for 1 hour. After a slow cool down, sausages were stored for 24 hours at 4°C until sensory evaluation. The laboratory production has been clarified at first the best method of plant blending and facilitated the optimisation of sausage processing on the use of medical plants. The additional process must guarantee a homogeneous mixture of all plant parts in the whole meat batter to ensure the calculated necessary average RDI per each 100 g sausage in interaction with an attractive sensory quality. After clarifying the medical plant addition, the conventional recipe was stepwise transferred at laboratory scale into a healthier one under warranty of product quality and the process steps were adapted on the new ingredients. To improve the nutritional value pork meat was replaced by turkey meat and pork fat by sunflower oil. Different amounts of meat and oil were tested. To reduce the sodium amount, the salt replacer Pansalt® was partly added in different amounts in place of nitrite curing salt. Pansalt® contains 57% sodium chloride, 28% potassium chloride, 2% lysine hydrochloride and 12% magnesium sulphate. Nitrite curing salt with varying nitrite amount was simultaneously tested to guarantee the microbiological product safety and the sensory quality (taste, colour)The developed healthier meat batter recipe and the chosen plant blending method were transferred into a pilot plant production to control all process steps and then sausage productions were realised under industrial conditions. For comparison of sensory properties, a control variant with a standard spice blend (amount of 0.6%) was used at laboratory scale and pilot plant production.

Results and Discussion

Medical plants. Based on literature review, finally 13 medical plants were selected from a large number of plants and the average recommended daily intake was calculated. The review has been shown, that the medical proven effect, the monography, also sensory properties depends on the plant parts (seed, rhizomes, flowers, leaves, steam and bark). It was also worked out, that different dried forms are available on the market (whole plant part, coarse and finer crushed, also fine powder). Table 1 shows the final selected medical plants, the evaluated dried parts, also the used forms and the calculated average RDI.

Table 1. Medical plants to create medical plant combinations (*used for final healthier sausages)

Medical plant (*Latin name*)	evaluated part / form	average RDI (g)
Anise (*Pimpinella anisum*)*	seed / whole*, crushed, powder	3
Dill (*Anethum graveolans*)*	seed / whole*, crushed, powder	3
Fennel (*Foeniculum vulgare*)*	seed / whole*, crushed, powder	6
Ginger (*Zingiber officinale*)*	rhizomes / crushed*, powder	3
Cardamom (*Elettaria Cardamomum*)*	seed / powder*	1.5
Coriander (*Coriandrum sativum*)*	seed / whole, crushed, powder*	3
Caraway (*Carum carvi*)*	seed / whole*, crushed, powder	3
Curcuma (*Curkuma longa*)*	rhizomes / powder*	2.3
Lavender (*Lavandula angustifolia*)	flowers / whole, crushed, powder	1
Melissa (*Melissa officinalis*)*	leaves / crushed*, powder	3
Sage (*Salvia officinalis*)	leaves / crushed	4
Milfoil (*Achillea millefolium*)	leaves, flowers, steam / crushed, powder	4.5
Cinnamon (*Cinnamomum verum*)	bark / powder	1

The used medical plants and her form used for combinations depend on a positive sensory evaluation by panel. Mainly, the plant ingredients are better water soluble as the more intensive flavour and colour confirmed. In that case, the application in cooked sausages will be possible, because they are rich in water. But a lot of plants has been showed a much bitter or astringent flavour and must be eliminated. The appearance is also an important fact that supports the creation of new sensory attributes. So plants that created a more untypical greyish or dark brownish colour than from

the review expected were also eliminated. Other colour variations like yellowish, greenish or reddish were accepted, because they should support a new and interesting product look. That's why whole parts were preferred as form to "see the healthiness", if they became softer after soaking. Only if plants are too firm, crushed or powdered forms are used. Medical plant combinations have composed from 2 to maximum 3 plants per mixture in different ratios to reach the proven preventive amount and to ensure sensorial recognisability of each plant. Out of a number of around 30 composed mixtures, the most flavour- and colour-pleasant 10 combinations were selected for first sausage production at laboratory scale for a conventional sausage recipe (*used for final 4 healthier sausages):

- Dill (whole), Coriander (powder), Melissa (crushed)*,
- Caraway (whole), Fennel (whole), Milfoil (powder),
- Melissa (crushed), Ginger (crushed),
- Coriander (powder), Curcuma (powder), Ginger (crushed)*,
- Lavender (whole), Cinnamon (powder),
- Coriander (powder), Caraway (whole), Cardamom (powder)*,
- Coriander (powder), Caraway (whole), Fennel (whole),
- Curcuma (powder), Ginger (crushed),
- Coriander (powder), Curcuma (powder), Cardamom (powder) and
- Aniseed (whole), Fennel (whole), Caraway (whole)*.

One of the biggest advantages was to create sensory acceptable sausages, because the added necessary plant content per 100 g sausage to guarantee the RDI was huge in comparison to the conventional spice amount (Figure 1). That has been influenced the sensory properties of the sausages very much.

The best 4 combinations were used for development of healthier meat batter recipe at laboratory scale, pilot plant and industry scale.

Figure 1. Amount per 1 kg final meat batter of spice blend (most left) and medical plant combinations (from left: AFC, DCM, CCG, CCC)

In case of homogeneous dispersion, the blending of plants should be realised after the final meat batter production by mixing. At laboratory scale, the mixing process was done manual. At pilot plant (5-liter chopper) and industry scale (100-liter chopper) the mixing function of the bowl chopper was used. The blending time should be around 30 second up to 1 minute at circa 100 rpm (depends on chopper and medical plant combination).

As essential result of medical plant use was the elimination of the traditionally used hot smoking step before boiling, because smoking shows a negative sensory effect on overall flavour (bitter and astringent) for the medical plants enriched meat batter.

The new ingredients caused some changes in meat batter production with choppers to ensure a high product quality. The 75% of turkey meat (GEHA PU III, leg, ≤ 15% fat and skin) was prepared as same as pork meat. Sunflower oil (25%) has to be chilled also on 4°C. The "dry chopping" step was adequate to the conventional production, but the conventional curing nitrite salt was replaced by one with a higher nitrate amount of 0.8-0.9% at a dosage of 1%, and also 1% Pansalt® was added too. Then, 30% of sunflower oil and the rest crushed ice were added and all was chopped at 2,500 rpm. When the meat batter starts to emulsify, the rest oil was blended stepwise. This stepwise procedure is necessary to allow the meat proteins to cover the fat drops completely. Only this creates a stable emulsified meat batter over time. The chopping process was stopped at 12°C. Finally, the medical plant combination was blended stepwise. All further process steps, except smoking, follows by traditional way. On base of only turkey meat and sunflower oil, also with the addition of Pansalt® the nutritional value of a developed healthier meat batter for "Lyoner" type cooked sausages were improved. By the use of different medical plant

combinations at a proven preventive RDI amount per 100 g sausage against gastrointestinal diseases, especially stomach and gut disorders, 4 variations were developed (Figure 2).

Figure 2. Developed cooked sausages (from left: DCM, AFC, CCG, CCC)

These sausages were influenced vast by the added medical plants in the intended RDI amount because they affected not only the sensory attributes at a wide range, also the technological parameters like emulsification properties and meat batter firmness. The use of as possible whole medical plant parts improved the addition of the selected plants because one bigger piece was not that much flavour intense than powder in the same amount. Therefore, higher dosage can be included and the necessary RDI can be reached easier.

Consumer preference tests. The results of the consumer preference tests for 653 participated people give a representative view of the German population by gender and age. The gender parts were 55.3% female and 42.6% male and the age parts were 19.1% ≤ 25 years, 24.7% 26-45 years, 38.1% 46-65 years and 16.5% > 65 years. The most consumers (circa 35%) preferred one or more combinations because her pleasant and delicious flavour and were ready to buy (Figure 3).

Only 12% of the people were not willing to buy a sausage. Female consumers have a bit more open mind for the new developed sensory properties, especially the taste. 19.6% described the healthier sausages as more pleasant and delicious than male (15.4%). But the willing to buy is on an equal level (15%) as for male (14.8%).
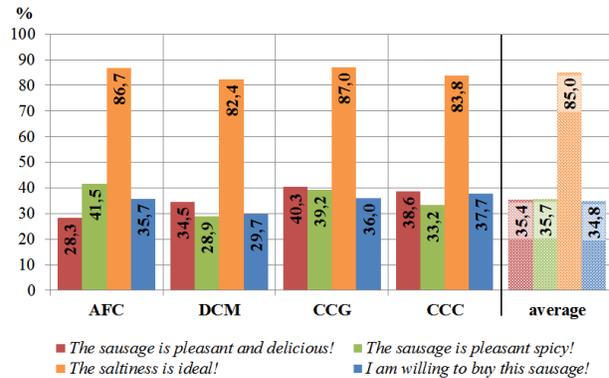
Figure 3. Overall acceptance of healthier sausages by pleasantness and spiciness, also willing to buy

By increasing age above 45 years up to 65 years, the consumers have shown a circa twice higher readiness to buy than the other age groups. The reduced sodium content was not criticised by 85% of the people. Only 10.6% described the sausages as to less salty. In tendency, the combination CCG is the most pleasant and delicious (40.3%) and AFC the least with only 28.3%, because this one was described as the spiciest (41.5%). Combination DCM shows the lowest noted spiciness (28.9%). Maybe this is the reason for the lowest readiness for buying at 29.7% in comparison to the others which reached around 36%. More than 30% of the consumers have been shown a high readiness for buying the developed sausages, especially consumers between ages of 45-65 years. This depends on the higher interest on a healthier lifestyle which included a healthier diet. These should prevent some disorders and should ensure a longer and healthier life. The growing understanding of the relationship between diet, specific food ingredients and health is leading people to new insights into the effect of food components on physiological function and health (Jimenez-Colmenero et al. 2010). The increasing knowledge about the preventive effects of medical plant helps to promote the marked launch of the developed sausages. The accepted reduction of sodium by 85% of the consumers shows the willingness to accept some sensory changes if the healthiness effect can be improved. Meat products contribute approximately 20-30% of the sodium in

a person's diet. Reducing sodium in the food can help the people to reduce their overall sodium intake up to the recommended 2 g per day (Dos Santos et al. 2015).

Conclusions

Functional products with health beneficial properties constitute an excellent opportunity for the meat industry to improve the quality and image of meat, especially processed meat products. Otherwise, the development of innovative healthy and high-quality sausages with medical plants was a big challenge.

A lot scientifically proven medical plants that are preventive against gastrointestinal diseases were detected and selected by especially a positive monography, a given RDI and the use in tea. As result of the medical plant selection and combination, finally 4 different combinations as the RDI amount per 100 g sausage were created for use in new developed healthier meat batter for cooked sausages type "Lyoner". The recipe guarantees, beside the health beneficial medical plant effects, a higher nutritional value. All pork meat was replaced by more protein rich and fat-lean turkey meat. All pork fat was substituted by poly unsaturated fatty acids and vitamins rich sunflower oil. Therefore, the fat content in the sausages was reduced about 33% from 30 to 20%. By European health claims (EU 2006), the sausages can be declared as "reduced", because the minimum level for this declaration is a reduction about 30%. Simultaneously, the protein content, which is free from connective tissue protein, was increased from 80 to 90%. By German law, the necessary minimum amount for this value for the selected cooked sausage type is 72%. For healthier sausage consumption, the sodium content was reduced about 25% by the use of the salt replacer Pansalz®. The nitrite content wasn't changed to ensure the product safety and colour properties.

The development of healthier sausages with medical plants was successful, as the consumer's preference tests shown. 35% of the people like the 4 selected combinations and the complete newly and extraordinary sensory properties by colour and flavour. To improve the acceptance for marked

launch the used medical plant combinations in the sausages were described by overall sensory property as: AFC "appetizing", DCM "fresh", CCG "exotic" and CCC "spicy".

The biggest problem in further industrial scale production will be to guarantee a constant concentration and the bio-availability of the medical effective ingredients not only throughout the various processing steps for sausage production. In dependence of the plant origin, the used drying method and storage conditions, the effective compounds can be varying.

Acknowledgements

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