

Method for Roasting and Surface-Pasteurization of Food Products

The device relates to a method for roasting and for the surface pasteurization of pieces of food products, in particular oleaginous seeds, such as almonds, hazelnuts, pecans, walnuts, as well as peanuts, bran, cereals, coffee, cocoa and the like. By nature, agricultural products and foods are loaded with harmless and potentially pathogenic micro-organisms. In most cases, agricultural products are processed fresh, or are made durable with the aid of suitable technological means. Among industrially employed preservation methods are counted, inter alia, sterilization or pasteurization by means of heat, irradiation with ionizing rays, or also gassing with lethally-acting gases. The two last-mentioned methods in particular can only be employed in a limited manner, since the use of these methods is strictly regulated by law.

In the past years, several cases of contamination of raw almonds with salmonella have been reported. For increasing the safety of almond products, the U.S. authorities have ordered that, starting in autumn of 2007, the entire almond harvest is to be pasteurized. The pasteurization of almonds and other oleaginous seeds makes special demands on the methods to be used. The water content of the almonds is not allowed to be increased to an appreciable degree by and during the treatment, because both the storage capability and the integrity of the almonds are harmed by this. Moreover, in the course of an intensive thermal or mechanical treatment raw almonds tend to lose the skin around the seed, which must also be considered to be a serious lack of quality.

Moreover, the US authorities have made the requirement that pasteurization can take place within the course of the customary

further processing steps, such as, for example, during blanching or roasting. Here, a sufficient inactivation must be assured by the sum of these process steps.

Various devices and methods have been described for hot-air roasting of nuts and almonds. A compilation of these methods can be found in Finke (1965), Kleinert (1966), Gaupp (1978), Bockelmann (1987) or Perren (1995). The hot-air roasting methods have in common that the nuts are charged with dry, hot air at 125°C to approximately 600°C, because of which the nuts are heated and are roasted within 8 to 60 minutes. Roasting is characterized by the formation of a roasting stage. By roasting, the water content is reduced to less than 2.5%, and the texture is modified to a crunchy-crackly and brittle texture. Furthermore, a roast color is formed in the range between light brown to dark brown, and a typical roasting aroma and a pleasant roasted taste are created.

An effective heat inactivation of micro-organisms is customarily obtained in an atmosphere of increased water activity.

In contrast thereto, micro-organisms are only inactivated to a limited extent by dry heating. Since roasting by means of hot air constitutes a treatment in a dry atmosphere, an assured inactivation of micro-organisms by hot-air roasting only takes place after a very long treatment time, or respectively at high temperatures.

Parameters which are required for achieving the inactivation of the described surrogates for Salmonella SE PT 30 at an order of magnitude of 4 log-units, are described in the "Guidelines for Validation of Dry Roast Processes" of the Almond Board of California. The described product temperature, or respectively time, combinations, which must be attained for a

minimal heat inactivation in the course of hot-air roasting, are so high that at these conditions high roasting stages and correspondingly dark roast colors are exclusively formed. Thus, only in the case of very advanced roasting stages is it possible to achieve an inactivation of micro-organisms of an order of magnitude of 4 log-units which, in accordance with the stipulation of the American authorities, does not permit a classification as "pasteurized".

In the two-stage roasting process of Perren et al. (1996), the hot air is subjected to moisturizing, which leads to an increase in atmospheric humidity. The described increase in humidity in the first process stage to approximately 10% here is not sufficient for creating an atmosphere which causes the assured inactivation of vegetative micro-organisms.

On the other hand, methods for sterilizing pieces of food, and in particular of almonds, have been described. A compilation of the methods accepted for pasteurizing almonds is provided on the website of the Almond Board of California (www.almondsarein.com).

Many described pasteurization methods deal with an isolated treatment of the products in a humid atmosphere at temperatures in the range between 60 and 100°C under normal pressure conditions. The exclusive aim of these methods is to reduce the contamination of the surfaces of the almonds by micro-organisms. Because of the short process duration and because of the humid atmosphere, these methods are not capable of forming a roasting stage. Neither is drying of the products to < 2.5% achieved, nor are a typical texture, roasting aromas and roast colors with these pasteurization methods.

Thus, no method is described in the prior art which is

capable to pasteurize nuts, almonds, oleaginous seeds and other goods in piece form simultaneously or in the same process in an assured manner, and to roast them in hot air.

It is the object of the invention to create a method of the type described at the outset, wherein hot-air roasting and pasteurization of food products are combined and both methods are united.

In accordance with the invention, this object is attained in that a treatment in a humid atmosphere is performed at a temperature $> 100^{\circ}\text{C}$, that pasteurization is performed in a roasting system during the roasting process, that during the pasteurization phase the temperature on the product surface is maintained a few degrees below the selected dewpoint temperature of the atmosphere, that pasteurization is performed within 1 to 30 min, and that in the course of advancing or continued roasting the condensation water on the surface of the food products is removed and the water absorption of the latter is minimized.

With this, conditions are created for inactivating vegetative germs under optimal conditions and in a short time. The roasting process is subsequently continued and the products are brought to the desired degree of roasting.

Pasteurization is optimized in that the treatment is performed in a humid atmosphere, preferably at temperatures between 50°C and 90°C , and that during the pasteurization phase the temperature on the product surface is preferably selected to lie 0°C to 8°C below the dewpoint temperature selected for the atmosphere. Advantageous embodiments of the method in accordance with the invention can be taken from the further dependent claims 4 to 6.

The invention will now be explained in greater detail by

means of an exemplary embodiment. Shown are in:

Fig. 1, a hot-air roasting installation NR, equipped with a steam injection device for the surface pasteurization during roasting of the material to be roasted, and

Fig. 2, an example of the time progression of the two-stage roasting process, interrupted by a pasteurization phase at a pile temperature of 105°C.

The method described is for example performed in a hot-air roasting system NR as represented in Fig. 1. A product charge is prepared in a preparation container and introduced into a roasting zone 1. Then air is aspirated by means of a ventilator 4, is heated by means of gas in a burner 5 and is centrally brought to the roasting zone 1. The hot roasting air is introduced into the material to be roasted via a rotating tuyère connection 3. As soon as the surface temperature of the material to be roasted has reached a preset pasteurization temperature in the range between 50 and 99°C, the pasteurization phase is started.

During the pasteurization phase the volume of the air flow through the roasting zone 1 is reduced to 0 - 20 Nm³/h/kg of the product by a flap system 13, and steam injection into the hot air is started via a valve 11 and a screen 12 at an order of magnitude of 0.01 - 15.0 kg steam/h/kg of the food product. The amounts of air and steam are of such a size that the dewpoint temperature of the hot air mixed with steam lies approximately 0 to 8°C above the surface temperature of the material to be roasted. Because of this temperature difference, water condenses on the product surface until the surface temperature equalizes the dewpoint temperature of the moistened hot air. Because of the water condensation, a water layer forms on the surface, in which optimal conditions for the inactivation of the vegetative micro-organisms

exist. These optimal pasteurization conditions are then maintained for 1 to 30 min, along with a constant flow of moist air and at a constant hot air temperature, until the desired or intended pasteurization effect has occurred. It must be noted that, because of the increase in the product temperature by 8°C, for example, an increase of the water content of the food product by max. 0.8% results because of the condensation of water vapor on the surface based on an approximate absorption of 0.1% water per °C.

Following the pasteurization phases, the two-stage roasting process, as described in Perrin et al. (1996) and in Perrin and Escher (1997), is continued. To this end, the introduction of steam is interrupted and the hot air volume flow is increased again to the predetermined degree. In the course of the continuation of the roasting process, the food products are still dried during the first stage of the roasting process (consisting of two roasting phases). In the second roasting stage the desired degree of roasting is then provided at a predetermined hot air temperature. An example of the progression of a two-stage roasting process, combined with a pasteurization phase, is represented in Fig. 2.

In order to minimize undesired qualitative changes in the food products it is necessary to reduce the absorption of water during the pasteurization phase as much as possible. This can be achieved if the product surface temperature is in agreement with the dewpoint temperature intended on the basis of the selected air and steam volume flow. From this then results the active phase of the pasteurization phase required for the inactivation of the micro-organisms. Examples of the pasteurization effect of the pure pasteurization phase in connection with almonds as a function

of the length of treatment and starting temperature of the pasteurization phase are recited in Table 1.

By means of the represented integration of a pasteurization phase into the hot air roasting method it becomes possible to pasteurize the food products and to roast them by means of hot air in only one method step. Moreover, the achieved pasteurization effect is independent of the degree of roasting to be achieved. In this way it is easily possible to pasteurize almonds and other food products dependably and reproducibly in the course of hot air roasting, without it being necessary to reach a dark roast color or a high degree of roasting.

The pasteurization method described here is also suitable for a combined pasteurization and roasting treatment of other oleaginous seeds, such as hazelnuts, pecans, walnuts, but also peanuts, bran, cereals, coffee, cocoa and the like.

In the course of a roasting process in hot air, the heat inactivation method introduced here is suitable for decisively reducing the microbial surface contamination of almonds, oleaginous seeds, as well as other piece-sized food products of medium or low water content, without the qualitative properties of the roasted food products being altered. Thus, in accordance with the stipulation of the US authorities it is therefore possible to speak of pasteurization, since by means of the method a reduction in the micro-flora, in particular salmonella SE TP 30, of 5 log-units is dependably achieved.

Table 1

Method parameters for surface pasteurization of raw almonds inoculated with *Enterococcus faecium* NRRL-B2354 NR-roasting installation in the course of roasting in a device with the two-stage roasting process. Roasting was terminated after the pasteurization stage and the two phases of the first roasting stage (phase 1: 170°C air temperature during 4 min; phase 2: 133°C air temperature during 4 min) for detecting the effect of the pasteurization stage. The initial contamination with *E. faecium* (reference organism) was $2 \cdot 10^7$ CFU/g.

Conditions during the Pasteurization Phase						
Pile	Hot air temp.	Hot air volume	Steam output	Length of time	Pressure	
for the start of pasteurization phase ¹						
°C	°C	Nm ³ /h/kg material	kg/h/kg material	min	mbar	
105	90	2	12	2	-10	
105	91	2	12	5	-10	

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 3  105      3  90      3    2      3  12      3  10      3 -10      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA^
 3  110      3  94      3    2      3  12      3    5      3 -10      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA^
 3  100      3  88      3    2      3  12      3    5      3 -10      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA^
 3  105      3  92      3    2      3  12      3    5      3 -10      3
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³ Mean content of <i>E. faecium</i>	³ log-reduction	³
³ after pasteurization	³	³
³ treatment	³	³

3	CFU	3	3
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Bibliography

Almond Board of California, 2007, "Guidelines for Validation of Dry Roast Processes", Modesto, CA.

H. Bockelmann, 1987, "Derzeitiger Entwicklungsstand der Herstellungstechnologie von gerösteten und gesalzenen Nüssen" [Present State of the Development of the Production Technology for Roasted and Salted Nuts], Süßwaren 31 (1/2), 39-44

A. Finke, 1965, "Handbuch der Kakaoerzeugnisse" [Manual of Cocoa Products], Springer, publishers, Berlin

E. Gaupp, 1978, "Vom hellsten bis zum dunkelsten Braun" [From the Lightest to the Darkest Brown Color], Süßwaren 22 (8), 22-29

J. Kleinert, 1966, "Einige Aspekte der Kakaobohnenröstung" [Some Aspects of Cocoa Bean Roasting], Gordan 66, 3 17

R. Perren, 1995, "Untersuchungen über das Rösten von Haselnüssen" [Research Regarding the Roasting of Hazelnuts], Dissertation ETH No. 11390, Swiss Technical University ETH, Zürich

R. Perren-Egli, T. Kerne, D. Sandmeier, K. Mayer-Potschak, 1996, "Verfahren zum Rösten von Ölsamen und Vorrichtung zum Durchführen dieses Verfahrens" [Method for Roasting Oleaginous Seeds and Device for Executing this Method], European Patent Application EP 0 729 705 A2

R. Perren, F. Escher, 1997, "Investigation on the Hot Air Roasting of Nuts", The Manufacturing Confectioner 77 (6), 123 - 127.

CLAIMS

What is claimed:

1. A method for roasting and for surface pasteurization of food product pieces, in particular, oleaginous seeds, such as almonds, hazelnuts, pecans, walnuts, as well as peanuts, bran, cereals, coffee, cocoa and the like,

characterized in that

treatment in a humid atmosphere is performed at a temperature $> 100^{\circ}\text{C}$, that pasteurization is performed in a roasting system during the roasting process, that during the pasteurization phase the temperature on the product surface is maintained a few degrees below the selected dew-point temperature of the atmosphere, that pasteurization is performed within 1 to 30 mins, and that, in the course of advancing or continued roasting, the condensation water on the surface of the food products is removed and the water absorption of the latter is minimized.

2. The method in accordance with claim 1,

characterized in that

the treatment is performed in a humid atmosphere, preferably at temperatures between 50°C and 99°C .

3. The method in accordance with claim 1,

characterized in that

in the pasteurization phase the temperature of the product surface is preferably selected to lie between 0°C to 8°C below the selected dew-point temperature of the atmosphere.

4. The method in accordance with claim 1,

characterized in that

a product charge is prepared in a preparation container and introduced into a roasting zone (1), that air is aspirated by means of a ventilator (4), is heated in a burner (5) by means of gas and is centrally brought to the roasting zone (1) and, as soon as the surface temperature of the material to be roasted has reached the pasteurization temperature, the pasteurization phase is initiated.

5. The method in accordance with claim 2,
characterized in that

a product charge is prepared in a preparation container and introduced into a roasting zone (1), that air is aspirated by means of a ventilator (4), is heated in a burner (5) by means of gas and is centrally brought to the roasting zone (1) and, as soon as the surface temperature of the material to be roasted has reached the pasteurization temperature, the pasteurization phase is initiated.

6. The method in accordance with claim 3,
characterized in that

a product charge is prepared in a preparation container and introduced into a roasting zone (1), that air is aspirated by means of a ventilator (4), is heated in a burner (5) by means of gas and is centrally brought to the roasting zone (1) and, as soon as the surface temperature of the material to be roasted has reached the pasteurization temperature, the pasteurization phase is initiated.

7. The method in accordance with claim 4,
characterized in that

during the pasteurization phase the volume of the air flow through the roasting zone (1) is reduced, that the steam injection into the hot air is started via a valve (11) and a screen (12), and that the amounts of air and steam are of such a size that the dewpoint temperature of the hot air mixed with steam lies approximately 0 to 8°C above the surface temperature of the material to be roasted.

8. The method in accordance with claim 5,
characterized in that

during the pasteurization phase the volume of the air flow through the roasting zone (1) is reduced, that the steam injection into the hot air is started via a valve (11) and a screen (12), and that the amounts of air and steam are of such a size that the

dewpoint temperature of the hot air mixed with steam lies approximately 0 to 8°C above the surface temperature of the material to be roasted.

9. The method in accordance with claim 6,
characterized in that

during the pasteurization phase the volume of the air flow through the roasting zone (1) is reduced, that the steam injection into the hot air is started via a valve (11) and a screen (12), and that the amounts of air and steam are of such a size that the dewpoint temperature of the hot air mixed with steam lies approximately 0 to 8°C above the surface temperature of the material to be roasted.

10. The method in accordance with claim 4,
characterized in that

in the course of the pasteurization phase the product surface temperature is brought into agreement with the dew-point temperature on the basis of the selected air and steam volume flow.

11. The method in accordance with claim 5,
characterized in that

in the course of the pasteurization phase the product surface temperature is brought into agreement with the dew-point temperature on the basis of the selected air and steam volume flow.

12. The method in accordance with claim 6,
characterized in that

in the course of the pasteurization phase the product surface temperature is

brought into agreement with the dew-point temperature on the basis of the selected air and steam volume flow.

13. The method in accordance with claim 7,
characterized in that
in the course of the pasteurization phase the product surface temperature is
brought into agreement with the dew-point temperature on the basis of the selected air
and steam volume flow.

14. The method in accordance with claim 8,
characterized in that
in the course of the pasteurization phase the product surface temperature is
brought into agreement with the dew-point temperature on the basis of the selected air
and steam volume flow.

15. The method in accordance with claim 9,
characterized in that
in the course of the pasteurization phase the product surface temperature is
brought into agreement with the dew-point temperature on the basis of the selected air
and steam volume flow.