

[54] FLEXIBLE COOKING CONTAINER
HAVING POWDER DISTRIBUTED OVER
ITS INTERIOR SURFACES
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[57] ABSTRACT
A flexible cooking container is treated so as to mini-
mize the danger of eruptions during cooking of food
therein. Before the food to be cooked is introduced
into the container, a small quantity of an edible pow-
der is distributed over the container's interior sur-
faces.

21 Claims, No Drawings

FLEXIBLE COOKING CONTAINER HAVING POWDER DISTRIBUTED OVER ITS INTERIOR SURFACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to cooking of articles of food in bags and sleeves of heat-resistant flexible material, such as heat-stabilized type 66 nylon and aluminum foil. Such bags and sleeves are presently being marketed by a number of companies for consumer use in oven cooking at temperatures from about 325°F. to about 425°F. The bags and the sleeves are used in the same manner, the only difference being that during cooking both ends of a sleeve are closed with a device such as a wire twist tie, while only the one end of a bag must be closed. Accordingly, the description herein will proceed with reference to bags, it being understood that the description will also apply to sleeves.

2. Description of the Prior Art

Instructions and recipes for use with cooking bags accompany bags presently being marketed; for example, the pamphlet "How to Use Your Reynolds Brown-In-Bag" accompanies a brand of such bags sold by Reynolds Metals Company.

In a typical such cooking process, the user initially preheats an oven to the desired temperature, for example 400°F. The food to be cooked is then placed in the bag and the bag is placed in a pan. Next, the bag is closed by a twist-tie about two inches outward of the food, and the excess material of the bag outward of this closure is cut away. Then, after several small holes are punched in the top of the bag to allow the escape of steam which will be generated during cooking, the pan, bag and food are placed in the oven and the food is cooked for an appropriate time. At the completion of cooking, they are removed from the oven and the top portion of the bag is slit to allow complete access to the food.

In such a typical process, the cooking bag offers several advantages. Since the bag contains juices evolved from the food during cooking, the oven and the pan are kept clean. In addition, most of the evolved juices remain in the bag, so as to provide a self-basting effect. A relatively transparent bag, such as one made of type 66 nylon, has the further advantage that it may be permeated by certain radiation that produces browning of the surface of the food.

RECOGNITION OF THE PROBLEM

After a large number of such bags had been marketed, I received reports of isolated occurrences wherein such bags had ruptured during cooking or upon or immediately after their removal from the oven. In most of such occurrences, hot liquids evolved were expelled from the ruptured bag. Those of such occurrences wherein the bag ruptured and hot liquids evolved were expelled from the ruptured bag will be hereinafter referred to as "eruptions." Usually the eruptions merely splattered liquids on the inside surfaces of the oven, but sometimes the eruptions occurred after the oven door had been opened and the liquids were also splattered on the user. In some cases the user was burned.

A number of such occurrences were carefully investigated, but initial attempts to reproduce eruptions experimentally were not successful. Many theories en-

deavoring to explain the eruptions were formulated, but were later abandoned, at least insofar as they were deemed to constitute explanations of the bulk of the reported eruptions. These theories included the following suspected causes of eruptions: the generation of vapor within the bag, until the bag ruptured, so that the sudden release of pressure created an explosion; sudden rupture of the bag for another reason, such as chemical degradation; an explosion of the article of food itself; bag deterioration resulting from ambient air conditions peculiar to certain geographical areas; the formation of combustible gases within the bag; excessively high cooking temperatures, as might be caused by malfunction of the thermostat regulating oven temperature; accumulation and explosion of the gas in a gas oven; concentration of heat on an edge of the bag hanging over the side of a pan; a sudden decrease in the ambient temperature; the superheating of oil vapor; accumulation of glycerine; melting of the bag by broiler elements; the cooking of frozen food; and the addition of extra basting oils, butters, sauces, wines and the like.

Eventually I was able to reproduce eruptions experimentally and thereby gain considerable insight as to their primary cause, by heating a mixture of 3 ounces of water and 8 ounces of oil in an oven until the oil reached a temperature of about 225° to 230°F. At this temperature violent eruptions almost always occurred, expelling most of the water and oil from their container. The eruptions occurred irrespective of whether the container holding the water and oil mixture was a pan, bowl, beaker, or cooking bag, and irrespective of whether the oil was vegetable oil, mineral oil, or melted lard. However, subsequent experiments showed that the presence of an article of food in such a mixture in a cooking bag greatly decreased the likelihood of an eruption. Eruptions occurred in less than 15% of these experiments wherein the article of food weighed 2 or 3 ounces, and did not occur at all in these experiments wherein the article of food weighed about 1 pound. Evidently the presence of the food product had frustrated my initial attempts to reproduce eruptions experimentally. I still have not been able to reproduce an eruption experimentally under normal cooking conditions.

SUMMARY OF THE INVENTION

In accordance with the present invention, a bag for enclosing an article of food during cooking thereof comprises flexible sheet material resistant to oven cooking temperatures and, in order to minimize eruptions during such cooking, is treated before the article of food is introduced into it by having a small quantity of an edible powder uniformly distributed over its interior surfaces. The powder is solid and insoluble in water at the cooking temperatures, and preferably is tasteless. Cooking flour is suitable. The more uniform the distribution of the powder, the less of it is required.

It is believed that individual particles of the edible powder introduced in accordance with the invention constitute sites for inducing heterogeneous nucleated boiling in meat juices evolved during cooking of the food and collected in the bag with their oil component overlying their water component, and that the provision of such sites alleviates superheating of the water component and the resulting sudden vaporization thereof known as "bumping."

The powder may be distributed in the bag manually, for example by the user's introducing it into the bag

and shaking it, or may be introduced in the course of processes for manufacturing the bag, for example extruding the bags or forming them from center folded sheet material.

DESCRIPTION OF PREFERRED EMBODIMENT

The presently preferred embodiment will now be described, it being understood that the invention may be otherwise variously embodied and practiced.

Cooking bags of the type that may be treated in accordance with the invention are presently marketed under the designation "Reynolds Brown-In-Bag". Such bags are made of transparent, heat-stabilized, type 66 nylon sheet material capable of resisting temperatures normally encountered in oven cooking, i.e., from about 325°F. to about 425°F. The bags come in the following three sizes, in order of width, depth, and sheet thickness: 10 × 16 × .00065 in.; 14 × 20 × .00085 in.; and 17 × 22 in. × .00100 in. Similar cooking bags are marketed in the U.S. by other companies, including Colgate-Palmolive Company, The Drackett Company, Union Carbide Corporation, General Foods Corporation, and McCormick & Company, Inc.

I treat such a cooking bag in accordance with the present invention by distributing over the interior surfaces of the empty bag a small quantity of an edible powder that is solid and insoluble in oil and water at the expected cooking temperature. As used herein, the term "insoluble" means incapable of forming an ionic or a molecular solution. Preferably the powder is tasteless, but it may be desired to provide flavored powder which can serve as seasoning for the article of food being cooked. Ordinary cooking flour is suitable. Non-lumping flour intended for use in making gravies is more readily wettable and is more suitable. Alternatively, other edible powders such as cornstarch, corn meal, matzo meal or the like can be used as the powder. The finer the powder, the more suitable it is believed to be.

The quantity of powder required is believed to vary inversely with the uniformity with which the powder is distributed over the interior surfaces of the bag. When the powder is uniformly distributed by being dusted over the interior surfaces of the bag, one fourth of one teaspoon thereof has been found to be adequate to prevent eruptions in the mixture of 3 ounces of water and 8 ounces of oil heated in the absence of an article of food in the manner described hereinabove. However, I recommend one teaspoon, or even as much as one tablespoon, in order to provide a safety factor and to compensate for any nonuniformity in the distribution of the powder.

A uniform distribution may be effected manually by introducing the powder into the interior of the bag through the mouth of the bag, and agitating the bag by grasping it near its mouth and shaking it vigorously. When the water and oil mixture is heated in a bag so treated the water in the mixture reaches its boiling temperature and is quickly boiled away without any eruption.

Although I do not consider my invention to be limited by any explanation of the scientific principles underlying its operation, I presently know of one explanation I believe to be generally correct.

According to this explanation, the eruptions in question are produced by a well known phenomenon of "bumping." Generally, as a liquid is heated its vapor

pressure increases until it equals the ambient pressure. Up to this point the liquid absorbs heat with a rise in temperature. Above this point any further heat input will be dissipated by boiling. At times, however, especially with immiscible liquids, boiling does not occur and the liquid's temperature increases above the boiling point. This condition is not stable and sooner or later boiling will start at some site. The excess energy stored in the liquid as temperature will be released in a fraction of a second as vapor. The resulting sudden increase in gas volume can displace overlying liquid, cause an immediate pressure build-up in closed containers, and generate a pressure wave producing a small muffled explosion.

More specifically, according to the aforesaid explanation, the temperature of a heated liquid depends on several factors: the heat added, the mass of the liquid, its heat capacity and the heat lost. These are related as follows:

$$T = T_i + 1/WC (Q_{in} - Q_{out}),$$

where T is the temperature of the liquid, T_i is the initial temperature of the liquid, W is the mass of the liquid, C is the heat capacity of the liquid, Q_{in} is the heat added to the liquid, and Q_{out} is the heat removed from the liquid. Heat may be added by several heat transfer mechanisms. Direct radiation from surrounding surfaces, convection of hot air and gases, and conduction from other materials that are hotter may contribute heat input to the liquid. The greater the heat input rate, the higher the rate of liquid temperature rise. Heat may be lost by the same heat transfer mechanisms. Heat can escape from the liquid by radiation, conduction, or convection to any surrounding surface or material that is colder than the liquid.

However, much more heat is lost through vaporization of the liquid. As the temperature of the liquid reaches its equilibrium boiling point, the percent of heat loss due to vaporization will normally increase greatly through surface evaporation. If evaporation is impeded, the heat loss will be less than heat input and the temperature will rise above the equilibrium boiling point and the liquid becomes superheated. In this state the liquid is highly unstable, a condition that will continue to worsen until a mechanism is established to discard the excess heat. The usual mechanism in this case is spontaneous or homogeneous nucleation which gives rise to a sudden, violent boiling called "bumping." The superheating can be avoided if the rate of heat loss by evaporation can be increased. This can be effectively accomplished by inducing nucleated boiling.

Now, nucleated boiling involves two separate and important processes: the formation of bubbles that can grow and the subsequent growth of these bubbles. Also, there are two kinds of nucleation. Homogeneous nucleation is the formation of interfaces within the inner bulk of the pure liquid. Heterogeneous nucleation is the formation of interfaces on the surfaces of foreign material, e.g., walls of containers, dust particles, and dissolved gases. We are referring here to inducing heterogeneous nucleation. The work required for heterogeneous nucleation is generally much lower than that required for homogeneous nucleation, which means that lower levels of superheating are present where heterogeneous nucleation is occurring. In fact, in the case of a foreign body whose surfaces are completely wet by the vapor, superheating is theoretically impossible.

Turning now to the application of these known physical principles to the problem to which my present invention is directed, the cooking of articles of food, such as meats, evolves water and fatty oils, commonly referred to as "meat juices." A cooking bag promotes the retention of the meat juices, so that water and oil can flow by gravity to some location in the bag and accumulate there. Since these liquids are immiscible, the oil covers the water in the accumulation, thereby virtually eliminating the surface evaporation of the water. The temperature of the water's surroundings tend to approach the oven temperature. Water, being a good thermal absorber, receives large heat inputs from these surroundings. The heat input may be from any direction; conduction through the pan or radiation of heat from the top. Since the water's vaporization is impeded by the overlying oils, the water temperature rises above the boiling point or becomes superheated at oven cooking temperatures, thereby leading to bumping, which in turn may burst the bag and expel hot water and oils and even food from the bag.

The present invention is believed to minimize the danger of such eruptions because the particles of the edible powder constitute sites to promote nucleated boiling of the collected water, thereby preventing excessive superheating thereof and consequential bumping, in accordance with the aforesaid scientific principles.

Other aspects of my invention relate to the provision of the edible powder for the bag during or immediately after the bag manufacturing process. Such provision permits the edible powder to be distributed more uniformly over the bag's interior surfaces, and eliminates the need for introducing the edible powder into the bag manually.

When the bags are to be made of an organic resin, such as type 66 nylon, one way of manufacturing them is to extrude the resin in the plastic state through a circular die orifice to form a tube, keeping said tube from collapsing while it is cooling by passing it over a "mandrel" of gas confined within it. Upon cooling, the tube is collapsed and flattened between nip rolls and severed at spaced intervals to form sleeves. If desired, the sleeves may be heat sealed at one open end to form a bag.

The edible powder may be distributed within such sleeves or bags by introducing it as a spray within the extruded tube while the tube is passing over the confined gas, so that the powder is deposited onto the inner surfaces of the tube. The electrostatic charge inherently on the tube will cause the particles of powder to cling to the tube's inner surfaces until the tube is collapsed and flattened. Exemplary apparatus for effecting a distribution in this manner is disclosed in U.S. Pat. No. 2,641,022 (Kress), especially FIG. 8 and the portions of the description referring thereto.

Another way to manufacture the cooking bags is to sever and heat seal short lengths of centerfolded sheet material, so that the fold becomes the bottom of the bag and the heat seals become its side edges. The edible powder may be distributed within such bags in the course of their manufacture by being sprayed or otherwise deposited on their interior surfaces, either before or after the severing and heat sealing operations.

When the edible powder is distributed over the interior surfaces of a bag in the course of manufacturing the bag, it may be desirable to temporarily seal the

mouth of the bag in order to protect the powder and the interior of the bag from exposure to ambient air and to keep the powder confined within the bag. Such a temporary seal should be formed so that it may be conveniently and completely broken by the user of the bag. Exemplary types of seals are known in the prior art, for example U.S. Pat. No. 2,643,049 (Bartelt).

It will be appreciated from the scientific explanation set forth hereinabove that another way to minimize the danger of eruptions in cooking bags would be to eliminate the overlying layer of oil in accumulations of meat juices therein. This could be accomplished by introducing into the bag an edible surfactant that forms an emulsion of the water and oil.

I claim:

1. A container for enclosing an article of food during cooking thereof, comprising flexible sheet material resistant to temperatures exceeding 325°F. and treated so as to minimize danger of eruptions during cooking by having distributed over the interior surfaces thereof a small quantity of an edible powder that at a cooking temperature of 325°F. is solid and insoluble in water, said container being devoid of said article of food.

2. A container according to claim 1 wherein said sheet material is nylon.

3. A container according to claim 1 wherein said edible powder is tasteless.

4. A container according to claim 1 wherein said edible powder is flour.

5. A container according to claim 1 wherein said edible powder is distributed substantially uniformly over the interior surfaces of said bag.

6. A container according to claim 1 wherein said quantity of said edible powder is no less than ¼ of 1 teaspoon and no greater than 1 tablespoon.

7. A container according to claim 1 which is a sleeve.

8. A container according to claim 1 which is a bag.

9. A bag according to claim 8 having a mouth that is temporarily sealed in order to protect said powder and the interior of said bag from exposure to ambient air and to keep the powder within said bag, said temporary seal being formed so that it may be conveniently and completely broken by the user of said bag.

10. A bag according to claim 8 wherein said material is nylon, said edible powder is tasteless, and said quantity is no greater than one tablespoon.

11. A bag for enclosing an article of food during cooking thereof, comprising flexible nylon sheet material resistant to temperatures exceeding 325°F. and treated so as to minimize danger of eruptions during cooking by having distributed over the interior surfaces thereof a small quantity of a tasteless edible powder that at a cooking temperature of 325°F. is solid and insoluble in water, said container being devoid of said article of food and said quantity being no less than one fourth of one teaspoon and no greater than one tablespoon.

12. A bag according to claim 11 wherein said edible powder is flour.

13. A process of preparing an article of food comprising the steps of:

providing an empty container comprising flexible sheet material resistant to temperatures exceeding 325°F.;

introducing into the interior of said container a small quantity of an edible powder that at a cooking temperature of 325°F. is solid and insoluble in water;

distributing said edible powder over the interior surfaces of said container, so as to minimize danger of eruptions during subsequent cooking of said article of food in said container;

introducing said article of food into said container having said edible powder distributed over its interior surfaces;
disposing said container and said food in an oven; maintaining said oven at an elevated temperature and at substantially atmospheric pressure, thereby heating and cooking said article of food; and removing said container and said cooked article of food from said oven.

14. A process of preparing an article of food comprising the steps of:

providing an empty container comprising flexible sheet material resistant to temperatures exceeding 325°F.;

introducing into the interior of said container a small quantity of an edible powder that at a cooking temperature of 325°F. is solid and insoluble in water; distributing said edible powder over the interior surfaces of said container, so as to minimize danger of eruptions during subsequent cooking of said article of food in said container;

introducing said article of food into said container having said edible powder distributed over its interior surfaces;

disposing said container and said food in an oven; maintaining said oven at a temperature not less than 325°F. and at substantially atmospheric pressure, thereby heating and cooking said article of food, whereby said heating causes liquid to exude from said article of food and to be collected by said container and particles of said edible powder constitute sites to promote nucleated boiling of said collected liquid, thereby preventing excessive superheating of said collected liquid and consequential bumping causing eruptions of said liquid from said container; and

removing said container and said cooked article of food from said oven.

15. A process according to claim 14 wherein said container is a bag.

16. A process according to claim 15 wherein said edible powder is distributed over said interior surfaces by agitation of said bag.

17. A process according to claim 16 wherein said agitation is performed by grasping said bag at its mouth

and shaking it.

18. A process according to claim 17 wherein said material is nylon, said edible powder is tasteless, and said quantity is no less than one fourth of one teaspoon and no greater than one tablespoon.

19. A process of preparing an article of food comprising the steps of:

providing an empty container comprising flexible sheet material resistant to temperatures exceeding 325°F.;

introducing into the interior of said container a small quantity of an edible powder that at a cooking temperature of 325°F. is solid and insoluble in water; distributing said edible powder over the interior surfaces of said container, so as to minimize danger of eruptions during subsequent cooking of said article of food in said container;

introducing said article of food into said container having said edible powder distributed over its interior surfaces;

closing an open end of said container, but providing for the subsequent escape of heated air and vapor from said container;

disposing said container and said food in an oven; maintaining said oven at a temperature not less than 325°F. and at substantially atmospheric pressure, thereby heating and cooking said article of food, whereby said heating causes oils and water to exude from said article of food and to be collected by said container with said oils overlying said water and particles of said edible powder constitute sites to promote nucleated boiling of said collected water, thereby preventing excessive superheating of said collected water and consequential bumping causing eruptions of said oils or water from said container, and

removing said container and said cooked article of food from said oven.

20. A process according to claim 19 wherein said container is a bag, said material is nylon, said edible powder is tasteless, and said quantity is no less than one fourth of one teaspoon and no greater than one tablespoon.

21. A process according to claim 20 wherein said edible powder is distributed over said interior surfaces by agitation of said bag performed by grasping said bag at its mouth and shaking it.

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