Syn allowed

NOSB NATIONAL LIST
FILE CHECKLIST

PROCESSING

MATERIAL NAME: Sodium Hydroxide

CATEGORY: Non-agricultural **Complete?:** 3/17

✓ NOSB Database Form

✓ References

✓ MSDS (or equivalent)

✓ FASP (FDA)

✓ Date file mailed out: 2/14/95

✓ TAP Reviews from: Bob Durst
Richard Theuer
Steve Taylor

✓ Supplemental Information:
Pretzels: Why Sodium Hyroxide ..... excerpts

MISSING INFORMATION: _____

NOSB/NATIONAL LIST COMMENT FORM/BALLOT

Use this page to write down comments and questions regarding the data presented in the file of this National List material. Also record your planned opinion/vote to save time at the meeting on the National List.

Name of Material Sodium Hydroxide

Type of Use: ____ **Crops;** ____ **Livestock;** ✓ **Processing**

TAP Review by:

1. Richard Theuer
2. Steve Taylor
3. Bob Durst

Comments/Questions:

My Opinion/Vote is:

Signature _____ **Date** _____

USDA/TAP REVIEWER COMMENT FORM

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Attach additional sheets if you wish.

This file is due back to us within 30 days of: 14 Feb

Name of Material: Sodium Hydroxide

Reviewer Name: Steve Taylor

Is this substance Natural or Synthetic? Explain (if appropriate)

Natural (if electrolysis is natural)

Please comment on the accuracy of the information in the file:

This material should be added to the National List as:

____ **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **This material does not belong on the National List because:**

Are there any restrictions or limitations that should be placed on this material by use or application on the National List?

Any additional comments or references?

Is electrolysis natural?

Signature Steve Taylor **Date** 3-5-95

USDA/TAP Reviewer Comment Form

Material: Sodium hydroxide

Reviewer: Bob Durst

Is this substance Natural or Synthetic? Explain (if appropriate)

Synthetic.

Please comment on the accuracy of the information in the file:

The file is accurate.

This material should be added to the National List as:

__X__ Synthetic Allowed, (see below)

_____ Prohibited Natural, or

_____ This material does not belong on the National List because:

Are there any restriction or limitations that should be placed on this material by use or application on the National List?

Pretzels: Use of a sodium hydroxide dip is the only method of producing a traditional pretzel. The included paper by Wightman, reviewing pretzel manufacturing is a good summary of the use and necessity of sodium hydroxide for the product.

Lye peeling: While manufacturers would like to be allowed to lye peel fruit, there are non–chemical alternatives that can be used instead. These are either very labor intensive (expensive) or require a suitable fruit variety to work well. By encouraging the planting of suitable varieties and understanding that the organic product is going to cost more due to the added labor costs, there is no reason that the same range of non–organic products can't be produced organically.

There is at least one other minor use that might be considered where it is probably critical (some other alkali treatment may substitute) for the process to use sodium hydroxide. Ripe olives are treated with NaOH to remove a bitter component. I have not encountered any processor trying to make organic olives, but someone may want to do this sometime.

Any additional comments or references?

As with all synthetic inorganic salts, source must be food grade. In addition each lot should be analyzed for toxic element concentrations (mercury, lead, cadmium, arsenic, thallium and antimony) and a near zero tolerance adopted.

Sodium hydroxide is widely used in many aspects of the food industry, not just as a product ingredient or processing aid. It is widely used as part of the formulation of alkaline cleansers that

are used to clean a processing plant. It is used as an adjuvant water treatment in many plants to adjust the pH of their wastewater to better allow municipal water treatment plants to process the water wastes.

There is come concern about any alkali treatment of food products that are high in protein regarding the formation of lysinoalanine. Lysinoalanine has been shown to have toxic effects in some animal species tested, but not in others. It also lowers the protein availability of the essential amino acid (lysine), which can markedly reduce the nutritional value of the food. It is my estimation that the conditions under which pretzel manufacturing occurs would not be conducive to the formation of these problem compounds, as time, alkaline conditions and heat are critical factors, with heat and time being a bigger influence than pH.

The above information came mostly from Food Chemistry by Owen R. Fennema. The citations in the book lead to many articles discussing this topic. One good article discussing this is: Bankhead, R. R., K. E. Weingartner, D. A. Kuntz, and J. W. Erdman (1978). Effect of sodium bicarbonate blanch on the retention of micronutrients in soy beverage. *J. Food Sci. 43* :345–348.

Signature Robert W. Dunn Date 3/1/95

4.

USDA/TAP REVIEWER
COMMENT FORM

Original mailing date: 14 Feb 1995.

Name of Material: Sodium Hydroxide 21CFR184.1763
Reviewer Name: Richard C. Theuer

SYNTHETIC Sodium hydroxide is produced by the electrolysis of a concentrated sodium chloride (common table salt) solution. Chlorine gas escapes from the solution, leaving behind a solution of sodium hydroxide, which is also called "caustic soda" or "lye." The chlorine gas is collected and sold as such.

COMMENTS RE SECTION 2119(m) CRITERIA:

1. Sodium hydroxide is an extremely caustic substance, so suitable protection should be employed in its use (avoidance of eye, skin and lung contact) and disposal.
2. Sodium hydroxide is used as a pH adjusting agent, to create useful and safer substances such as sodium citrate. It is also used as a processing aid (such as in cocoa manufacture and in pretzel manufacture).
   Sodium hydroxide is a GRAS (Generally Recognized as Safe) substance [21CFR184.1763].
4. Sodium hydroxide is allowed in lye peeling of fruits and vegetables [21CFR173.315]. This method of peeling has a significant adverse environmental impact due to the combination of spent lye and high BOD (biological oxygen demand) from the waste vegetable matter. Historically this method has therefore been considered unacceptable for organic food processing. A environmentally superior method of peeling is steam peeling, which uses pressurized steam and no chemicals.

The following substance should be added to the National List of Substances as an allowed synthetic ingredient in Organic Food as a pH control agent and as a minor processing aid:

sodium hydroxide

The lye-peeling process should not be allowed for organic food processing.

February 22, 1995

NOSB Materials Database

5.

Identification

Common Name	**Sodium Hydroxide**	**Chemical Name**	
Other Names	Caustic Soda, Lye		
Code #: CAS	1310-73-2	**Code #: Other**	
N. L. Category	Non-agricultural	**MSDS**	◉ yes ○ no

Chemistry

Family	
Composition	NaOH
Properties	White, or nearly white, pellets, sticks, flakes, fused masses, or other forms. Readily absorbs carbon dioxide and moisture. Soluble in water and alcohol.
How Made	Chlorine and sodium hydroxide are co-products of electrolysis of aqueous solutions of sodium chloride (7647-14-5), NaCl (common name brine).
	Processing

Use/Action

Type of Use	
Specific Use(s)	Alkali, lye peeling. Caustic bath for pretzels. Processing aid for cocoa manufacture. Removing bitterness from olives. Also a widely used component of many alkaline cleansers used in processing plants. Used as an adiuvant water treatment to adiust the pH of their waste water.
Action	Two main functions in pretzel making: Prior to baking to alter proteins and starch so that the surface becomes smooth, and to develop brown color during baking.
Combinations	

Status

OFPA	
N. L. Restriction	
EPA, FDA, etc	FDA-GRAS
Directions	
Safety Guidelines	Caustic. Use suitable protection for skin, lungs and eyes.
State Differences	
Historical status	Allowed by OR Tilth for pretzels. Prohibited for lye peeling by most certifiers.
Internationl status	

NOSB Materials Database

OFPA Criteria

2119(m)1: chemical interactions **Not Applicable**

2119(m)2: toxicity & persistence **Not Applicable**

2119(m)3: manufacture & disposal consequences

Sodium Hydroxide is diluted to a 2% solution for the caustic bath and there is no environmental consequences from its actual use. The effluent is then diluted further and drained into sewage systems to balance the acidic nature of other effluent. EPA is responsible for monitoring compliance to manufacturing guidelines.

Lye peeling waste has a significant negative environmental impact because of spent lye and high BOD (Biological oxygen demand).

2119(m)4: effect on human health

Must be handled according to manufacturer guidelines because of caustic nature. Concentration is routinely monitored in pretzel production to make sure of complete conversion to sodium bicarbonate during baking.

2119(m)5: agroecosystem biology **Not Applicable**

2119(m)6: alternatives to substance

None which provide caramelizing and browning properties for pretzels.
For lye peeling, steam peeling is an alternative with less environmental consequences.
No good alternative for olive processing.

2119(m)7: Is it compatible?

References

Kirk-Othmer Encyclopedia of Chemical Technology, 4th Ed., Wiley, NY

Food Chemicals Codex, 3rd Ed., National Academy Press, Washington D.C. 1981.

Maga, J.A. 1991. Cereal based snack foods. Ch 20 in Handbook of Cereal Science and technology, K.J. Kulp, (ed.), 793-814, Marcel Dekker, Inc., NY

Matz, S.A. 1984. Baked Snacks, Ch 15, in Snack Food Technology, 2nd. ed. 173-191. AVI Publishing Co., Inc., Westport, CT

Nell Newman, 1994, written communication, Newmans Own Organics, Aptos, CA

Wightman, JoLynne D., 1994. Pretzels: Why sodium hydroxide is needed in the process. (excerpts attached)

MATERIAL SAFETY DATA SHEET
SODIUM HYDROXIDE

SECTION I - Product Identification

PRODUCT NAME: SODIUM HYDROXIDE
FORMULA: NAOH FORMULA WT: 40.00
CAS NO.: 01310-73-2 NIOSH/RTECS NO.: WB4900000
COMMON SYNONYMS: CAUSTIC SODA; SODIUM HYDRATE; LYE
PRODUCT CODES: 3730,3722,3722,5312,5104,3729,3734,3726,5045,3728,5022,3736, 3723

Precautionary Labeling

BAKER SAF-T-DATA(TM) SYSTEM
HEALTH - 3 (POISON)
FLAMMABILITY - 0
REACTIVITY - 2
CONTACT - 4 (CORROSIVE)
LABORATORY PROTECTIVE EQUIPMENT
GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
PRECAUTIONARY LABEL STATEMENTS
POISON DANGER
CAUSES SEVERE BURNS
MAY BE FATAL IF SWALLOWED
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
AVOID BREATHING DUST. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING.

SECTION II - Hazardous Components

COMPONENT	%	CAS NO.
SODIUM HYDROXIDE	90-100	1310-73-2

SECTION III - Physical Data

BOILING POINT: 1390 C (2534 F) VAPOR PRESSURE(MM HG): 0
MELTING POINT: 318 C (604 F) VAPOR DENSITY(AIR=1): N/A
SPECIFIC GRAVITY: 2.13 EVAPORATION RATE: N/A
(H2O=1) (BUTYL ACETATE=1)
SOLUBILITY(H2O): APPRECIABLE (MORE THAN 10 %) % VOLATILES BY VOLUME: 0
APPEARANCE & ODOR: WHITE, ODORLESS SOLID (FLAKES).

SECTION IV - Fire and Explosion Hazard Data

FLASH POINT: N/A NFPA 704M RATING: 3-0-1
FIRE EXTINGUISHING MEDIA: USE WATER SPRAY.
UNUSUAL FIRE & EXPLOSION HAZARDS
CONTACT WITH MOISTURE OR WATER MAY GENERATE SUFFICIENT HEAT TO IGNITE COMBUSTIBLE MATERIALS.
REACTS VIOLENTLY WITH WATER LIBERATING AND IGNITING HYDROGEN.

SECTION V - Health Hazard Data

THRESHOLD LIMIT VALUE (TLV/TWA): 2 MG/M3 (PPM)
EFFECTS OF OVEREXPOSURE
INGESTION MAY RESULT IN SEVERE INTESTINAL IRRITATION WITH BURNS TO MOUTH.
CONTACT WITH SKIN OR EYES MAY CAUSE SEVERE IRRITATION OR BURNS.
EMERGENCY AND FIRST AID PROCEDURES
CALL A PHYSICIAN.
IF SWALLOWED, DO NOT INDUCE VOMITING; IF CONSCIOUS, GIVE LARGE AMOUNTS OF WATER. FOLLOW WITH DILUTED VINEGAR, FRUIT JUICE OR WHITES OF EGGS, BEATEN

WITH WATER.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.
WASH CLOTHING BEFORE RE-USE.

SECTION VI - Reactivity Data

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR
CONDITIONS TO AVOID: MOISTURE
INCOMPATIBLES: WATER, STRONG ACIDS, MOST COMMON METALS

SECTION VII - Spill and Disposal Procedures

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.
WITH CLEAN SHOVEL, CAREFULLY PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER; REMOVE FROM AREA. FLUSH SPILL AREA WITH WATER.
J. T. BAKER NEUTRACIT-2(R) CAUSTIC NEUTRALIZER IS RECOMMENDED FOR SPILLS
DISPOSAL PROCEDURE
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.
EPA HAZARDOUS WASTE NUMBER: D002, D003 (CORROSIVE, REACTIVE WASTE)

SECTION VIII - Protective Equipment

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.
RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 60 PPM, A HIGH-EFFICIENCY PARTICULATE RESPIRATOR IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS ADVISED.
EYE/SKIN PROTECTION: GOGGLES, UNIFORM, APRON, RUBBER GLOVES RECOMMENDED.

SECTION IX - Storage and Handling Precautions

SAF-T-DATA(TM) STORAGE COLOR CODE: WHITE STRIPE
SPECIAL PRECAUTIONS KEEP CONTAINER CLOSED. STORE IN CORROSION-PROOF AREA.

SECTION X - Transportation Data and Additional Information

DOMESTIC (D.O.T.)
PROPER SHIPPING NAME SODIUM HYDROXIDE, DRY SOLID
HAZARD CLASS CORROSIVE MATERIAL (SOLID) UN/NA UN1823
LABELS CORROSIVE REPORTABLE QUANTITY 1000 LBS.
INTERNATIONAL (I.M.O.)
PROPER SHIPPING NAME SODIUM HYDROXIDE, SOLID
HAZARD CLASS 8 UN/NA UN1823
LABELS CORROSIVE

(TM) and (R) : Registered Trademarks
N/A = Not Applicable OR Not Available
The information published in this Material Safety Data Sheet has been compiled from our experience and data presented in various technical publications. It is the user's responsibility to determine the suitability of this information for adoption of necessary safety precautions. We reserve the right to revise Material Safety Data Sheets periodically as new information becomes available.
Copyright by Manufacturer
LICENSE GRANTED TO MAKE UNLIMITED COPIES FOR INTERNAL USE ONLY
by OREGON STATE UNIVERSITY

10.

Pretzels: Why sodium hydroxide is needed in the process

Historical Background

The origin of the pretzel dates back to 610 AD where in a monastery in the Alps of Savoy, monks made pretzels as rewards for children learning their prayers. The first commercial pretzel bakery in the United States was started by Julius Sturgis in Lititz, PA in 1861. Originally pretzels were all made soft. The hard pretzel variation came about when a batch of freshly baked pretzels were accidently left in the oven after baking (Madonna, 1983). More accurately the pretzels were left in a cooling oven and the remaining heat dried them, removing the moisture, and giving them a hard, crisp texture and a golden coating. A later development was the dipping of the pretzel in a hot solution made from either wood ash or straw water. This allowed the dough to become sticky enough to hold coarse salt and it also gave pretzels their characteristic brown glaze and flavor (Madonna, 1983). Today, this is accomplished by dipping the pretzel dough in hot sodium hydroxide.

Formulation

The exact formulations for each companies' pretzels are a trade secret, but a typical formulation for traditional hard and soft pretzels is given below. In addition to yeast leavening, stick and twist pretzels are often leavened with chemical agents. Common leavening agents include ammonium bicarbonate and sodium bicarbonate (Maga, 1991). Two of the latest trends in pretzel making are the addition of flavors and "filled" pretzels.

Typical formulas for hard and soft pretzels

Ingredients (%)	hard pretzel	soft pretzel
water	25.0	31.22
flour	71.6	62.44
yeast	0.3	1.95
salt	1.0	1.46
shortening	2.1	0.99
sugar	-	1.46
vinegar	-	0.24
powdered milk	-	0.24

(Hamed, 1991; Matz, 1993)

Processing

The most characteristic operation in the pretzel process is the dipping in lye (sodium hydroxide) solution. There is no equivalent process in the manufacture of other snack foods. A common process scheme for traditionally shaped pretzels is shown in Figure 1. Pretzel making practices have not changed greatly over the last 40 years and at the present time it is still more of an art than a science. Therefore, the pretzel manufacturer is very reluctant to discuss his operations with outside technologists (Matz, 1984). Thus, ingredient quantities as well as baking times and temperatures will vary slightly between different processors.

The first step in the process is the formation of the sponge. Approximately 20% of the flour, 30% of the water and the yeast are mixed together and fermented for about 10 hours. Although the pretzels receive a short proofing period, they are usually not fermented again. The remaining flour and water, along with the other ingredients, are then added to form a stiff dough. Pretzel dough has to be made very stiff so that it will withstand the punishment of machining without becoming sticky or misshapen. The dough is then either extruded and cut (as in the production of various shapes) or shaped into the traditional pretzel form and knotted by rollers. These shapes are allowed to proof or rest for about 10 minutes and then are passed through a hot sodium hydroxide bath for 10-25 seconds. Immediately after emerging, the pretzels are conveyed under a salt hopper and are covered with 8-10% salt (the final product only contains approximately 2% salt due to losses during processing). The last stage of the process is a run through a series of ovens. In the first oven segment, a high temperature is used to carmelize the gelatinized starch on the surface of the pretzel to produce a dark brown color. The second and third segments are to dry the pretzel stepwise, to approximately 15% moisture and then to a final moisture content of 2-4%.

Lye Dip

There are two main functions of sodium hydroxide in the pretzel making process. It is used prior to baking to alter proteins and starch so that the surface becomes smooth and to develop a deep brown color during baking (Lindsay, 1985). A lesser function is to form a wet, sticky surface to improve the adherence of the salt. Sodium hydroxide is a very strong base and as of yet, no substitute has been found that can impart the same desired characteristics to the finished product.

The characteristic brown, glossy surface of both the large soft and the smaller, crisp pretzels is the result of the lye dip. The dip solution is pH 13 and typically contains about 0.5% to 1.25% sodium hydroxide or 2% sodium carbonate (Maga, 1991; Matz, 1993), although sodium carbonate is not as effective as sodium hydroxide. The dip is maintained between 180-212°F (82-100°C) and pretzel immersion time is about 10-25 seconds. Another, less used, method of application is by spraying where the pretzels move on a belt through a sodium hydroxide "waterfall".

The application of this solution must be carefully controlled so that the pretzel emerging from the hot bath does not contain unreacted alkali, which would cause an unpleasant sensation in the mouth when the pretzel is consumed. If the caustic concentration becomes too high, there is not a complete conversion to sodium bicarbonate in the baking and drying cycles (Matz, 1984). The basic reaction of the sodium hydroxide is with carbon dioxide in the air to form sodium bicarbonate ($NaOH + CO_2 \rightarrow NaHCO_3$), (Hoseney, 1986) which is a commonly used leavening agent (Lindsay, 1985). As of 1984, there appeared to be no FDA regulation on the amount of sodium hydroxide in the caustic solution. Under the Nutrition Labeling and Educational Act of 1990, the amount of sodium in a product must be labeled on the package.

At the Snack Food Association's 1989 Pretzel Seminar, Timothy M. Harris, the marketing director of Ulrich Chemical, Inc., Indianapolis, Indiana, explained the production of caustic soda (the lye dip), "It is sodium chloride and water, that's all that make up caustic soda" (Greczyn, 1989). Caustic soda is a byproduct of chlorine. It can also be used to make organic chemicals, inorganic chemicals, pulp and paper, aluminum, soaps, petroleum, cotton, and for various other applications in the food processing industry.

Functionality of Sodium Hydroxide

The alkaline solution (lye dip) reacts with both the protein and starch on the surface layer of dough. During this process it also loses its corrosive character (Matz, 1993). The smooth outer surface of the pretzel is due to the denaturation of proteins and their interaction with the gelatinizing starch. Baking alone does not induce extensive denaturation (or breaking down) of the gluten proteins in the wheat flour, beyond that which occurs during the mixing and kneading of the dough. But, due to the extremely high pH of the lye dip, strong electrostatic repulsions of ionized groups inside the molecule occur causing unfolding of the protein molecules on the surface (Cheftel et al., 1985). Above 70-80°C, gluten proteins release some moisture and this water is absorbed by the partly gelatinized starch granules. Since the lye dip is maintained between 82-100°C, gelatinization of starch and denaturation of the proteins occur rapidly. As the temperature is increased, the starch molecules vibrate more vigorously, breaking intermolecular bonds and allowing their hydrogen-bonding sites to engage more water molecules (Smith, 1982). The rate of starch swelling is greatly increased above pH 10.0 also. When the starch granule is heated in the presence of base, the hydrogen bonds in the amorphous region are ruptured and the granules swell with progressive hydration. The more tightly bound micelles remain intact, holding the granule together (Smith, 1982). Birefringence is lost and as the granule continues to expand, more water is imbibed, more space is occupied, movement is restricted and the viscosity increases.

The brown color of the pretzel is due to carmelization of the gelatinized starch. The direct heating of carbohydrates (starch in this case) produces a complex group of reactions termed "carmelization". The initial thermolysis causes dehydration with formation of anhydro rings, or introduction of double bonds into sugar rings (Whistler and Daniel, 1985). The latter produces intermediates to unsaturated rings, such as furans. Conjugated double bonds absorb light and produce color. Often in unsaturated ring systems, condensation will occur to polymerize ring systems, yielding colors and flavors. Increasing temperatures and increasing pH increases the reaction rate substantially: the rate at pH 8.0 is ten times that at pH 5.9 (Whistler and Daniel, 1985). Thus the sodium hydroxide dip raises the pH and increases the reaction rate. Certain pyrolytic reactions produce unsaturated ring systems that have unique tastes and fragrances such as maltol and isomaltol which contribute to the flavor of baked bread (and pretzels).

Sodium hydroxide is used as a food additive in many other food products (Lindsay, 1985). Ripe olives are treated with solutions of sodium hydroxide (0.25-2.0%) to aid in the removal of the bitter principal and to develop a darker color. A sodium hydroxide treatment is also used in the preparation of hominy and tortilla dough to destroy the disulfide bonds in the flour proteins.

Economic Value

Consumers are finally beginning to realize that pretzels are a low-fat snack and that they fit into the health conscience diet of today. Pretzels also have a lower-than-average price compared to other snacks. These are two of the reasons why pretzel sales have increased in double-digit rates over the last four years. In 1988, pretzel sales amounted to $459.8 million but had increased to

13.

$833 million by 1992 (Anonymous, 1993). To capitalize on this economic growth, more and more companies are adding traditional pretzel lines, as well as developing new shapes and flavors.

Related Products

There are a few closely related products to the traditional hard and soft pretzels. The main difference is that they do not undergo the sodium hydroxide dip process (Hoseney, 1986). Bagels are formulated similarly to pretzels but they are boiled and then baked. Although large, soft pretzels may undergo the sodium hydroxide dip, as in the crisp pretzels, some are made quite differently. They may be made similar in formulation to the soft pretzels mentioned above, but they are bathed with sodium carbonate instead of sodium hydroxide, and others are just baked in a hot oven.

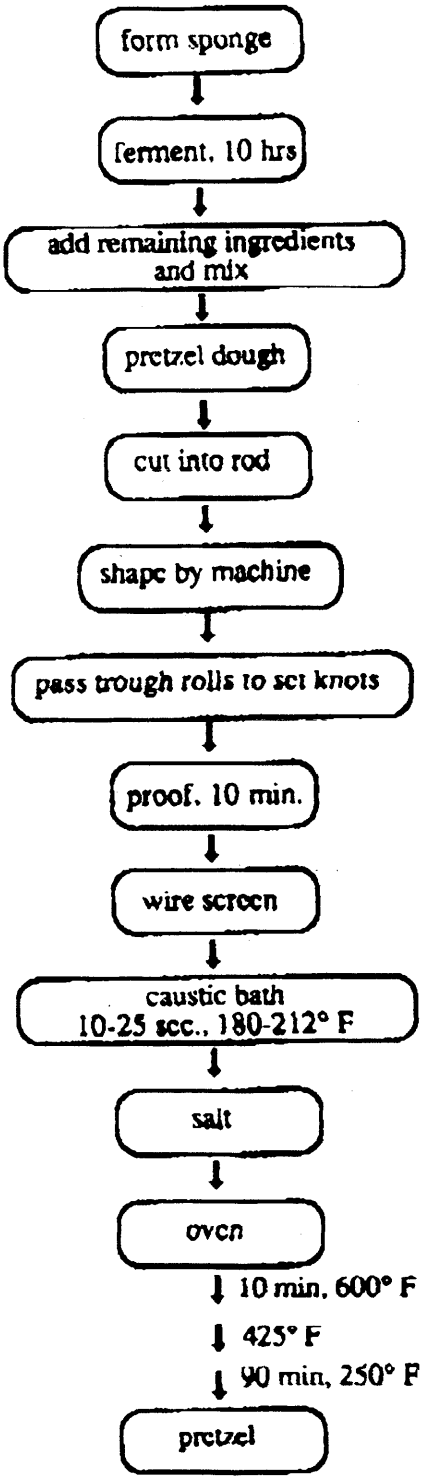

Figure 1. Typical pretzel process (Hoseney, 1986).

15.

References

Anonymous. 1993. Pretzels maintain upward growth spurt. Snack World. 50:SW26-SW27.

Cheftel J.C., Cuq, J.-L. and Lorient, D. 1985. Amino Acids, peptides, and proteins. Ch. 5, In *Food Chemistry*, 2nd ed, O.R. Fennema (Ed.), 245-370. Marcel Dekker, Inc., New York.

Hamed, F. 1991. Soft Wheat Products. Ch, 17, In *Handbook of Cereal Science and Technology*, K.J. Lorenz and K. Kulp, K (Ed.), 683-740. Marcel Dekker, Inc., New York.

Hoseney, R.C. 1986. Snack foods. Ch. 14, In *Principles of Cereal Science and Technology*, 305-316. American Association of Cereal Chemists, Inc., St. Paul, MN.

Greczyn, M.A. 1989. A gathering of twisted minds. Snack World. 46(12):52-53.

Lindsay, R.C. 1985. Food Additives. Ch. 10, In *Food Chemistry*, 2nd ed, O.R. Fennema (Ed.), 629-688. Marcel Dekker, Inc., New York.

Madonna, M.D. 1983. Pretzels as low calorie snacks. Cereal Foods World. 28(5):297-299.

Maga, J.A. 1991. Cereal-based snack foods. Ch. 20, In *Handbook of Cereal Science and Technology*, K.J. Lorenz and K. Kulp (Ed.), 793-814. Marcel Dekker, Inc., New York.

Matz, S.A. 1984. Baked Snacks. Ch. 15, In *Snack Food Technology*, 2nd ed. 173-191. AVI Publishing Company, Inc., Westport, CT.

Matz, S.A. 1993. Baked Savory Snacks. Ch. 14, In *Snack Food Technology*, 3rd ed. 173-184. Van Nostrand Reinhold/AVI., New York.

Smith, P.S. 1982. Starch derivatives and their use in foods. Ch. 14, In *Food Carbohydrates*, D.R. Lineback and G.E. Inglett (Ed.), 237-269. AVI Publishing company, Inc., Westport, CT.

Whistler, R.L. and Daniel, J.R. 1985. Carbohydrates. Ch. 3, In *Food Chemistry*, 2nd ed, O.R. Fennema (Ed.), 69-138. Marcel Dekker, Inc., New York.

CNUM=2749

U.S. FOOD AND DRUG ADMINISTRATION
FOOD ADDITIVE SAFETY PROFILE

SODIUM
~~DIUM~~ HYDROXIDE

S#:	001310732	HUMAN CONSUMPTION:	106.6384	MG/KG BW/DAY/PERSON
SP#:	2749	MARKET DISAPPEARANCE:	125833333.333LBS/YR	
PE:	ASP	MARKET SURVEY:	87	
S#:	0192	JECFA:	NL	
MA#:		JECFA ADI:		MG/KG BW/DAY/PERSON
AS#:		JECFA ESTABLISHED:	1965	
		LAST UPDATE:	931215	
:	40	DENSITY:	LOGP:	

RUCTURE CATEGORIES: A7

MPONENTS:

NONYMS:
CAUSTIC SODA
CAUSTIC SODA, LIQUID
SODIUM HYDRATE
SODA LYE
WHITE CAUSTIC
SODIUM HYDROXIDE (NA(OH))
LYE

EMICAL FUNCTION: D

CHNICAL EFFECT:
PH CONTROL AGENT
PROCESSING AID
FUMIGANT
WASHING OR SURFACE REMOVAL AGENT
DOUGH STRENGTHENER
FLOUR TREATING AGENT
OXIDIZING OR REDUCING AGENT
FLAVORING AGENT OR ADJUVANT
COLOR OR COLORING ADJUNCT
FLAVOR ENHANCER

R REG NUMBERS:

173.310	184.1763	163.110
172.560	172.892	172.814

NIMUM TESTING LEVEL: 3

MMENTS: STUDY 1-7 FROM SCOGS-85
DATA INSUFFICIENT FOR PRIORITY RANKING

16.

CNUM=2749

X 7: ACUTE TOXICITY INFORMATION

UDY: 1 SOURCE: MERCK INDEX 8TH ED 960
ECIES: RABBIT YEAR: 1968
LD50: 500 MG/KG BW
MMENTS:

X 9: ORAL TOXICITY STUDIES (OTHER THAN ACUTE)

UDY: 6 COMPLETENESS: SOURCE: ENDOCRINOLOGY 28:897-906
PE: SUBCHRONIC RODENT YEAR: 1941
ECIES: RAT LEL: > MG/KG BW/DAY
RATION: 93 DAYS HNEL: 1 MG/KG BW/DAY
FECTS: NO EFFECTS
TES:
MMENTS: ADMINISTERED BY STOMACH TUBE 3X/WEEK
FEMALES ONLY
COMPLETE NECROPSY AND HISTOPATH

UDY: 5 COMPLETENESS: SOURCE: J NATL CANCER INST 7:67-70
PE: RODENT (NON-RAT) ONCOGENICITY YEAR: 1946
ECIES: MOUSE LEL: > MG/KG BW/DAY
RATION: 300 DAYS HNEL: 200 MG/KG BW/DAY
FECTS: NO EFFECTS
TES:
MMENTS: NO NEOPLASTIC OR PRENEOPLASTIC LESIONS IN THE GASTRIC MUCOSA
ONE DOSE LEVEL ONLY, BY GAVAGE

UDY: 4 COMPLETENESS: SOURCE: J NUTR 5:421-429
PE: SPECIAL TOXICOLOGICAL STUDY YEAR: 1932
ECIES: RAT LEL: 700 MG/KG BW/DAY
RATION: HNEL:
FECTS: FERTILITY INDEX DECREASE
TES:
MMENTS: BODY WEIGHT DECREASED AT 1500 MG\KG
NO FEMALES CONCEIVED; DURATION NOT REPORTED
REPORTING INCOMPLETE

UDY: 3 COMPLETENESS: SOURCE: VET SCI ANIM IND 13:347-358
PE: SPECIAL TOXICOLOGICAL STUDY YEAR: 1939
ECIES: RABBIT LEL: 5000 MG/KG BW/DAY
RATION: HNEL:
FECTS: ULCERATION
TES: STOMACH
MMENTS: ADMINISTERED IN COW'S MILK

17.