The decomposition of starch in the preparation of cooked sausage (ring bologna) in Finland

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Certain pork cuts used in the preparation of ring bologna sausage in Finland cause enzymatic decomposition of the potato flour added into the emulsion. The processed sausage becomes soft, crumbly, exudative and sweet. This is due to the presence of α-amylase in the cuts. The α-amylase activity calculated for each type of cut increases in the following sequence: diaphragm meat (0,18 Units/g), organ meat (1,26 U/g), head meat (1,33 U/g), stick site meat (1,50 U/g) and cheek meat (1,61 U/g). The α-amylase activities of pork cuts taken from four slaughterhouses were found to be in the ratio 1 : 1,7 : 2,3 : 3,8. The amylolytic activity of the animal feeds had no effect on the α-amylase activity of the cuts. 48-72 hours of precuring increased the α-amylase activity of the cuts by 4-18 %. 99 % of the amylase extracted from meat was inactivated by heating for 10 minutes at 70°C.

The maximum α-amylase activity permitted for the sausage suspension (the threshold value for restricting the decomposition of starch) is 0,1 U/g. Exceeding this value leads to the above mentioned defects in sausage preparation. The threshold value is not exceeded if the α-amylase-active pork cuts do not exceed 4 % of the weight of the sausage emulsion.

Stärkeabbau bei der Herstellung finnischer Brühwurst

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Bestimmte bei der Herstellung finnischer Brühwurst zu verarbeitende Schweineteilstücke bewirken einen enzymatischen Abbau des dem Brät zugesetzten Kartoffelmehls; dadurch wird das Produkt weich, krümlig, exsudativ und süsslich. Bewirkt wird dies durch die in den Teilstücken enthaltene α-Amylase. Die teilstückbezogene α-Amylasenaktivität nimmt in der Reihenfolge Zwerchfellmuskel (0,18 Einh./g), Organmuskel (1,26 E/g), Kopfmuskel (1,33 E/g), Stichstelle (1,50 E/g) und Backenmuskel (1,61 E/g) zu. Die α-Amylasenaktivitäten der Schweineteilstücke aus vier verschiedenen Schlachthöfen standen im Verhältnis 1 : 1,7 : 2,3 : 3,8. Die amylolytische Aktivität des Futters hatte keinen Einfluss auf die α-Amylasenaktivität der Teilstücke. Ein 48- bis 72stündiges Vorsalzen steigerte die α-Amylasenaktivität der Teilstücke um 4 bis 18 %. Die aus dem Fleisch extrahierte α-Amylase wurde bei 70°C innerhalb von 10 min zu 99 % inaktiv.

Die maximal zulässige α-Amylasenaktivität des Bräts, der sog. Schwellenwert zur Begrenzung des Stärkeabbaus, beträgt 0,1 E/g. Eine Überschreitung dieses Wertes führt bei der Wurst zum o.g. Herstellungsfehler. Der Schwellenwert wird nicht überschritten, wenn man maximal 4 % α-amylasenaktive Schweineteilstücke, bezogen auf das Brätgewicht, verarbeitet.

6.8

La degradation de l'amidon dans la fabrication du saucisson de cuisson finlandais

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Certaines catégories de morceau du porc utilisées pour la préparation du saucisson de cuisson finlandais provoquent la dégradation enzymatique de la farine de pomme de terre ajoutée à la masse, ce qui rend le saucisson mou, friable, aqueux et trop doux. Ceci est dû à l'amylase α contenu dans ces catégories. Appréciée par catégorie de morceau, le pouvoir amylolytique α croît selon l'ordre suivant: diaphragme (0,18 Unité/g), organes (1,26 U/g), tête (1,33 U/g), poitrine dans la région de la pique (1,50 U/g) et joue (1,61 U/g). Les pouvoirs amylolytiques α des catégories de morceau de quatre abattoirs différents se trouvaient dans les rapports 1 : 1,7 : 2,3 : 3,8. Le pouvoir amylolytique des fourrages utilisés pour l'alimentation des animaux n'a pas d'influence sur le pouvoir amylolytique α des catégories de morceau. Cette dernière est augmentée de à 18 % par un présalage de 48 à 72 heures. L'amylase α extrait de la viande est neutralisée à 99 % si elle est soumise durant 10 minutes à une température de 70°C.

Le pouvoir amylolytique α maximum toléré pour la masse de viande, correspondant à la valeur appelée seuil assignée à la limitation de la dégradation de l'amidon, est défini par 0,1 U/g. Toute valeur supérieure entraîne dans les saucissons le défaut de fabrication mentionné plus haut. Ce seuil n'est pas dépassé si des catégories de morceau de porc possédant un pouvoir amylolytique α ne sont utilisées que pour un maximum de 4 % de la masse de saucisson.

Раложение крахмала в процессе изготовления финской варенной колбасы.

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Известные сортименты свинины применяемые при изготовлении финской круговой колбасы вызывают разложение примешенного крахмала и вследствии этого констистенция колбасы получается мягкая,неровная,водянистая и сладковатая.Установлено что явление вызывает αамилаз свинины. Вычисленная активность αамилаза каждого сортимента увеличивается в следующем порядке: брюшное мясо/0,18 Унит/г/,внутренние органы/1,26 У/г/,головное мясо/1,33 У/г/,колотная рана /1,50 У/г/и щечное мясо /1,61 У/г/.Отношения αамилаза сортиментов свинины из четырех разных скотобоин были:1:1,7:2,3:3,8.Активность амилаза употребляемого корма не имела влияния на активность αамилаза свинины.После 48 -72 соления активность αамилаза сортиментов увеличилась на 4 -18%.Экстрагированный из мяса αамилаз инактивировался в течении 10 минут в температуре 70°С до 99%.

Наивысшая допускаемая активность αамилаза колбасной массы,т.н.величина порога,ограничивающая расложение крахмала у нас 0,1 У/г.Переступление этой величины и вызывает вышеописанные дефекты.Величину порога можно не переступать применением αамилозоактивные сортименты свинины не более 4% веса колбасной массы.

6.8

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Introduction

Finnish ring bologna contains on average 8 % potato starch, 7 % pork and beef head, cheek and organ meat, 25 % pork and 15 % beef. Its chemical composition reads: 60 % water, 18 % fat and 10 % protein. The caliber of the sausage varies from 3,2 to 4,3 cm. The ring bologna produced by certain meat products factories have been soft, crumbly, exudative and sweet. The starch content of these sausages has been surprisingly low (3-4 %) compared with the normal 8-10 % content.

Starch has been shown to break down during cooking of the sausage (1). The post mortem α-amylase activity of pork is 22 times higher than that of beef (2). The hydrolysis of starch which takes place during the preparation of sausage is due neither to bacteria nor to autolysis. The greater the sausage caliber the more starch hydrolyses; the hydrolysis is more pronounced inside the sausage than on its surface. Starch has been shown to break down in ring bologna containing organ meat (1). Amylase does not hydrolyse ungelatinous starch, and even a small amount of gelatinization promotes hydrolysis (1,3). The amylase activity of pig liver extract is considerably greater than that of extract of musculus psoas major (3).

This study sets out those pork cuts which give rise to starch hydrolysis. The α-amylase activity of these cuts is also determined. In order to restrict starch hydrolysis during emulsion processing and cooking a threshold value is determined for the α-amylase activity of the emulsion. This value can be used to overcome the drawbacks in preparation mentioned above.

Material and methods

Activity determinations. Five cuts from 20 split pig carcasses were used as the test material. The parts were: cheek (one cheek from the split carcass), head (meat obtained from cleaning the head), stick site (the blood-covered parts removed from around the stick point), organ meat (what remains of the diaphragm meat after removal of the organs) and diaphragm meat (meat remaining on the carcass). The average weights of these parts were 340, 389, 444, 169 and 103 g, respectively. In addition, the effect of the amylolytic activity of the fodder used to feed these 10 pigs on the α-amylase activity was also investigated.

The α-amylase activity was determined from pre-cured meat using an enzyme-specific substrate (Phadebas amylase test/Pharmacia). The meat was precured by cutting it into pieces and adding a 30 % sodium chloride solution corresponding to 10 % of the weight of the meat. The meat was precured for 24 hours at +4°C before being homogenised in a laboratory cutter (Robot 2) for two minutes. The enzyme was extracted by adding 25 ml of distilled water to 30 g of homogenate. The enzyme solution was separated by inserting a small filter paper cone into the suspension. 0,2 ml of solution was taken from within the cone and placed in a test tube with 4 ml of distilled water. The mixture was equilibrated to 37°C for 5 minutes and the substrate added in the form of a tablet. The reaction time was 15 minutes (37°C, pH 7). Inactivation was achieved by adding 1 ml of 0,5M NaOH. The absorbance of the filtered solutions was measured by a spectrophotometer (Zeiss) at 620 nm.

The activity (Units/g) was calculated as follows: the activity (U/ml) obtained from the standard curve log (U/l) = 0,87 x $\log A_{620}$ + 2,80 was multiplied by the quotient: water used in extraction (ml)/weight of meat (g).

The amylolytic activity of the fodders was determined using the dinitrosalicylate (DNSA) method. The α-amylase activity of the fodders (amylase test) was also determined. 30 g of ground barley was suspended for 24 hours in 90 ml of 0,05M veronal (sodium diethylbarbiturate), which is 0,2M with respect to NaCl and 0,001M with respect to $CaCl_2$ (pH 7,2). Filtered solutions were used for activity determinations. For DNSA determination 1 ml of soluble starch was added to 1 ml of filtrate. After incubation for 10 minutes (37°C, pH 7) the reaction was stopped by adding 2 ml of DNSA solution. After cooking for 5 minutes 15 ml of distilled water was added to

the mixture. The reducing power of the coloured reaction mixtures was measured by spectrophotometer (Zeiss) at 540 nm against the barley extract.

The activity (Units/g) was calculated as follows: the activity (U/ml) obtained using a glucose standard curve U (µmol glucose/min) = 1,52 x A_{540} was multiplied by three (= 90 ml/30 g).

Threshold value. The sausage emulsions were prepared according to the following recipe: beef 13,7 %, pork 24,8 %, skin emulsion 6,0 %, potato flour 10,0 %, powdered milk 4,0 %, water 38,7 %, salt 2,0 %, phosphate, erythorbate, ascorbate and spice 0,8 % and nitrite 150 ppm. To determine the α-amylase activity, 10 emulsions, each weighing 5 kg, were prepared, in which the pork was replaced by pork cheek (0-100 %) with an α-amylase activity of 1,40 U/g. After chopping (Seydelmann), samples were taken from the emulsions for the amylase test. The chopped emulsion was stuffed into a Naturin casing, predried, smoked and cooked for 45 minutes at 74°C (Foodco). Starch determinations were carried out on the prepared sausages (Nordisk Metodik-Komite, No. 52 1964).

Results and discussion

1. α-amylase activity of pork cuts

The activities of pork cuts determined by means of the amylase test are shown in Table 1. The mean α-amylase activity calculated for each cut increases in the sequence: diaphragm meat, organ meat, head, stick point and cheek. Deviations from this order for the various slaughterhouses are perhaps due to differences in the animals as well as to the different meat cutting methods employed.

There were considerable differences in the α-amylase activities of the meat obtained from the 20 pork carcasses used as test material. In cheek meat the activity varied from 0,08 to 5,09 U/g, in stick point from 0,14 to 8,37 U/g, in head meat from 0,11 to 4,14 U/g, in organ meat from 0,09 to 4,37 U/g and in diaphragm meat from 0,13 to 0,31 U/g. It should be pointed out that the cheek and stick point with the highest activity came from the same animal. The cheek, head and organ meat with the lowest activity also came from the same animal. Twelve cheek and head cuts, four organ cuts and three stick point cuts had extremely high activities (> 2,40 U/g).

Table 1 Mean α-amylase activities of pork cuts from four slaughterhouses

Cut	α-amylase activity (Units/g)				Mean
	1	2	3	4	
Cheek	3,06	0,85	0,98	1,54	1,61
Stick	0,34	-	2,03	2,14	1,50
Head	1,28	0,84	2,40	0,81	1,33
Organ	0,33	0,62	2,83	-	1,26
Diaphragm	0,20	-	0,18	0,17	0,18

The α-amylase of cheek and head meat is formed in the salivary glands (glandula parotis, glandula sublingualis and glandula submandibularis). The α-amylase of stick point comes via the blood serum, and that found in organ and diaphragm meat is probably formed in the pancreas or liver.

2. Amylolytic activity of fodder

Table 2 shows the amylolytic activity (α and β-amylase activity) of the fodders used to feed the ten pigs, together with the α-amylase activity of the corresponding meat.

The amylolytic activity of the fodder used to feed pig no. 8 was the lowest, although its α-amylase activity was high. The cheek and stick point meat of this pig had the highest α-amylase activity. Pig no. 6 was fed on amylase-active fodder; however, the α-amylase activity of the meat from this pig was low.

Table 2 Amylolytic activity (DNSA) of the barley used for feeding the pigs, vs. the α-amylase activity of the meat

Pig	Fodder (U/g)		Pork cuts (U/g)				
no.	DNSA	a-test	cheek	head	stick	organ	diaphragm
1	3,9	0,19	3,54	0,55	0,44	0,29	0,31
2	3,3	0,32	3,25	2,63	0,40	-	0,18
3	3,9	0,51	1,90	0,31	0,45	0,15	0,15
4	3,3	0,03	3,57	2,16	0,28	0,28	0,16
5	3,6	0,34	3,40	0,77	0,14	0,20	0,18
6	5,1	1,73	0,19	0,22	0,19	-	0,16
7	6,9	0,89	0,85	0,23	0,43	-	0,17
8	1,8	1,71	5,09	2,63	8,37	-	0,21
9	5,4	0,49	0,96	0,24	0,87	-	0,17
10	6,6	0,09	0,63	0,72	0,83	-	0,15

3. Precuring and heating

Cheek, head and stick point meat was precured by adding 30 % sodium chloride solution corresponding to 10 % of the weight of the meat. The mixture was homogenised in a laboratory cutter and the homogenate was stored for 24, 48 and 72 hours at +4°C.

On the basis of the amylase test a precuring time of 24 hours had no effect on the enzyme activity, a curing time of 48 hours brought about an increase of 4-18 % in the activity, and after 72 hours the increase was 11-15 % over the original activity. The increase in α-amylase activity brought about by chloride ions may be promoted by cutting the meat finely in a cutter, in which case the fineness becomes more significant than the curing time.

To establish the temperature of inactivation of α-amylase an active cheek extract (2,99 U/g at 37°C) was heated for 10 minutes at 50, 60 and 70°C. The amylase test showed that 87, 10 and 1 % respectively of the original activity remained. Raising the temperature slowly during cooking promotes the hydrolysis of starch in the sausage. This is due to the fact that the enzymatic reaction velocity doubles for each 10°C rise in temperature, and to the slow thermal inactivation of the enzyme. The enzymatic hydrolysis of starch is also affected by the caliber of the sausage (1).

4. Threshold value

A subjective assessment has shown that 1,7 % at most of the potato starch (8 %) added to sausage can be allowed to decompose. If more starch decomposes the sausage becomes soft, crumbly, exudative and sweet.

In order to limit the decomposition of added starch to 1,7 % a threshold value for the α-amylase activity of the sausage emulsion was determined in this study. When α-amylase activity of the chopped emulsion is 0,1 Units/g the decomposition of added starch will be restricted to 1,7 % (Fig. 1).

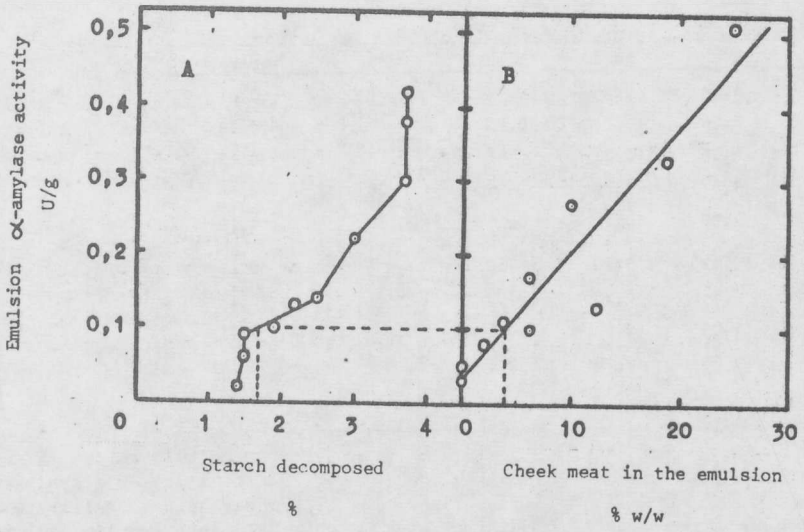

Fig. 1 The emulsion α-amylase activity plotted against the amount of starch decomposed (A), and the threshold value of the emulsion α-amylase activity (0,1 U/g) plotted against the sausage recipe (B). The only variable in the recipe is the proportion of amylase-active (1,4 U/g) cheek meat.

Fig. 1 shows that the threshold value for the sausage emulsion is not exceeded provided the sausage emulsion does not contain more than 4 % w/w α-amylase-active pork cuts.

Fig. 2 depicts a method for determining the amounts of α-amylase-active meat in the recipe.

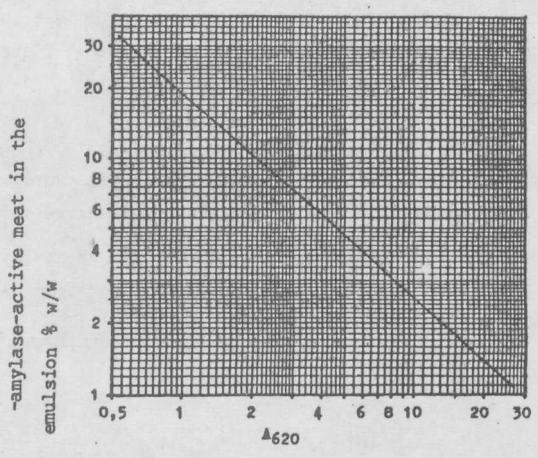

Fig. 2 The amount of pork cuts in the recipe limited by the threshold value (0,1 U/g). The maximum permitted amount (% w/w) in accordance with the α-amylase activity of the meat (absorbance at 620 nm) is read from the curve. Assuming an absorbance measurement A_{620} of 8 (4), a maximum of 3 % w/w (5,6 %) of the cut can be used in the emulsion.

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