

Possibility of using textiles as casing materials in fermented sausages



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CASING

- The word **casing** suggests a **container or covering** which enclose the foodstuff (**meat batter, ham mass, etc.**) in order to hold or protect the product.
- The **function of casing** requires **to form** (a round shape), **protects** and preserves the product content from contamination and deterioration, thereby extending shelf life.
- **The primary roles** of any casing are shaping or forming of the meat product, capacity to **withstand pressure** at filling and upon applying the closure (twisting or clipping) and **providing selective permeability** which is the primary feature for shelf life of the product.
- **The secondary roles** of casings to have **thermal resistance, special surface effects, printability, curving or ringing capability** and other more supplementary characteristics.



Table 1. Classification of sausage casings according to origin



Animal origin

Intestine

Non-edible collagen casings

Edible collagen casings

Plant origin (synthesized)

Cellulose casings

Fibrous cellulose casings

Combined origin

Textile casings

Linen casings

Synthetic

PVDC casings

Polyester casings

Polyamide (nylon) casings

Multilayer casings (nylon + polyolefin + other polymers)



Table 2. Comparison of different casings in terms of some features

Casing Specifications	Type of Casing			
	Natural	Collagen	Cellulose	Textile
Unit price	Cheap	Cheaper	-	Cheapest
Durability	Weak	Moderately durable	Durable	Most durable
Soaking and softening before use	Soaking in water / salt water	Soaking in water / salt water	Sometimes soaking	Direct use / soaking in water
Property of fume penetration	Most	Less	Least	Adjustable according to fabric type and weaving density
Suitibility of machine operation	Least	Less	Most	Most
Ability to produce in desired size and diameter	No	Yes	Yes	Yes
Daily loss / Oven loss	%8-10/ %1-2	%10/ %1-2	-	Adjustable according to fabric type and weaving density
Hygienic property	Low	Good	Good	Best
Storage capability	Least	Medium	More	Most
Reusable after soaking	No	No	No	Yes
Printability	None	Limited	Good	Best



Objective of the study

- In this research, **as an alternative** to the commonly used natural and artificial sausage casings, **it is aimed to compare new casing materials made from different fabrics** with similar or enhanced properties.
- The possibility of **using different textiles as casing materials in fermented sausages as an alternative to the gauze like muslin cloth** was investigated.
- The **effects of types fabric, structural features and thread density of fabric on the quality** of fermented sausages were studied.



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Material and Methods

- **Meat and fat** used in sucuk production were provided from a local butchery, *Pediococcus pentosaceus* and *S. carnosus subsputilis* were the starter cultures in a standard recipe of Öz et al. 2002.
- The fermented sausage dough with/without starter culture was filled in **6 different casings** made **of natural, artificial (collagen)** and **4 different fabric materials**.

Type of Sausage Casing (Cloths were sewn 25x12cm)	Without starter culture	With starter culture
Natural casing (beef small intestine)	S1	K1
Artificial casing (collagen)	S2	K2
100% cotton case with Ne20 yarn number	S3	K3
100% cotton case with Ne30 yarn number	S4	K4
100% polyester case with Ne20 yarn number	S5	K5
35% cotton / 65% polyester case with Ne20 yarn number	S6	K6



- The samples were subjected to **fermentation in a chamber for 12 days**. The chamber conditions during fermentation were as follows: $24 \pm 1^{\circ}\text{C}$ - 90% RH for first 3 days, $22 \pm 1^{\circ}\text{C}$ - 85% RH for the following 4 days and $18 \pm 1^{\circ}\text{C}$ - 80% RH for 5 days. After fermentation, the sausages eventually were packed and **stored at $+4^{\circ}\text{C}$ for 32 days**.

Material and Methods (cont.)

- The **pH** levels of the product were determined using a pH meter.
- **% dry matter** content was determined by AOAC (2000).
- **Color** measurement was performed using a CR-5 colorimeter.
- The **TMAB** number of the sausage samples was determined by drop plate method in the plate count agar (PCA, Merck) medium.
- The **LAB count** was determined using MRS agar, at 37°C for 72hours.
- The total **yeast and mold** was determined using Dichloran Rose Bengal Chloramphenicol agar and incubated at 25°C for 3 to 5 days.
- The **sensory properties** was evaluated with a 9-point hedonic scale with boundary descriptors ranging from “do not like at all” to “like very much”.



Results and Discussion



Results and Discussion

Table 3. **TMAB counts** during various fermentation and storage stages of sausage samples (log cfu /g)

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	6,98 \pm 0,04Aa	8,82 \pm 0,05Eb	9,29 \pm 0,01Da	9,02 \pm 0,03Fab	9,12 \pm 0,05Abab	8,90 \pm 0,07Db	8,83 \pm 0,18ABCb
S2	6,98 \pm 0,04Aa	8,85 \pm 0,00Ecd	9,46 \pm 0,01Ba	9,26 \pm 0,08CDab	9,09 \pm 0,13Bbc	9,00 \pm 0,00CDbcd	8,74 \pm 0,06BCd
S3	6,98 \pm 0,04Aa	9,20 \pm 0,00Db	9,27 \pm 0,01Db	9,29 \pm 0,01BCDb	9,32 \pm 0,00Abbc	9,47 \pm 0,01Aa	8,90 \pm 0,07ABCc
S4	6,98 \pm 0,04Aa	9,25 \pm 0,07CDa	9,25 \pm 0,02Da	9,23 \pm 0,04Dea	9,23 \pm 0,04Aba	9,18 \pm 0,00CDa	8,74 \pm 0,06BCb
S5	6,98 \pm 0,04Aa	9,25 \pm 0,02CDB	9,27 \pm 0,01Db	9,28 \pm 0,03BCDb	9,21 \pm 0,04Abbc	9,45 \pm 0,02ABa	8,78 \pm 0,00BCc
S6	6,98 \pm 0,04Aa	9,27 \pm 0,01CDa	9,25 \pm 0,02Dab	9,22 \pm 0,02DEab	9,09 \pm 0,13Bbc	9,26 \pm 0,11ABCab	9,00 \pm 0,00ABc
K1	7,26 \pm 0,31Aa	9,41 \pm 0,01ABa	9,37 \pm 0,01Ca	9,10 \pm 0,02Efb	8,81 \pm 0,05Cc	8,87 \pm 0,04Dc	8,30 \pm 0,00Dd
K2	7,26 \pm 0,31Aa	9,46 \pm 0,01Aa	9,47 \pm 0,01Ba	9,04 \pm 0,00Fb	9,06 \pm 0,03BCb	8,87 \pm 0,04Dc	8,65 \pm 0,07Cd
K3	7,26 \pm 0,31Aa	9,41 \pm 0,00ABa	9,43 \pm 0,03BCa	9,40 \pm 0,05ABCa	9,20 \pm 0,04Abb	9,47 \pm 0,01Aa	9,00 \pm 0,00ABc
K4	7,26 \pm 0,31Aa	9,34 \pm 0,03BCa	9,37 \pm 0,01Ca	9,34 \pm 0,03ABCDa	9,23 \pm 0,00Abb	9,40 \pm 0,02ABa	8,93 \pm 0,04ABCc
K5	7,26 \pm 0,31Aa	9,42 \pm 0,01ABab	9,58 \pm 0,00Aa	9,45 \pm 0,01Aab	9,36 \pm 0,08Aab	9,42 \pm 0,12ABab	9,13 \pm 0,18Ab
K6	7,26 \pm 0,31Aa	9,45 \pm 0,00Aa	9,39 \pm 0,01Cab	9,41 \pm 0,01Aba	9,30 \pm 0,06Abab	8,80 \pm 0,14Dc	9,15 \pm 0,00Ab

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Table 4. Average **LAB counts** during various fermentation and storage stages of sausage samples (log cfu /g)

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	8,00 \pm 0,00Aa	8,10 \pm 0,02Id	9,02 \pm 0,03BCa	8,97 \pm 0,10ABab	8,90 \pm 0,00BCab	8,88 \pm 0,04ABb	8,65 \pm 0,07ABCDc
S2	8,00 \pm 0,00Aa	8,16 \pm 0,03Id	9,00 \pm 0,00BCDa	8,98 \pm 0,04ABab	8,93 \pm 0,11BCab	8,74 \pm 0,06ABCDb	8,48 \pm 0,00Dc
S3	8,00 \pm 0,00Aa	8,72 \pm 0,03Gab	8,78 \pm 0,00Eab	8,91 \pm 0,06ABa	8,90 \pm 0,07BCa	8,74 \pm 0,06ABCDab	8,65 \pm 0,07ABCDb
S4	8,00 \pm 0,00Aa	8,50 \pm 0,00Hbc	8,39 \pm 0,13Fc	8,78 \pm 0,25ABab	8,89 \pm 0,16BCa	8,48 \pm 0,00Dbc	8,78 \pm 0,00ABab
S5	8,00 \pm 0,00Aa	9,00 \pm 0,00Fa	8,82 \pm 0,05DEab	8,65 \pm 0,07Bbc	8,93 \pm 0,11BCa	8,54 \pm 0,08CDc	8,82 \pm 0,05Aab
S6	8,00 \pm 0,00Aa	9,06 \pm 0,03EFab	8,88 \pm 0,04CDEab	9,12 \pm 0,16ABa	8,82 \pm 0,17BCab	8,82 \pm 0,05ABCab	8,65 \pm 0,07ABCDb
K1	8,15 \pm 0,21Aa	9,35 \pm 0,01BCa	9,27 \pm 0,02Aa	9,10 \pm 0,02ABab	8,97 \pm 0,10Bab	8,69 \pm 0,30ABCDb	8,70 \pm 0,00ABCb
K2	8,15 \pm 0,21Aa	9,13 \pm 0,03DEab	8,93 \pm 0,04BCDEbc	9,10 \pm 0,02ABab	9,25 \pm 0,02Aa	8,80 \pm 0,14ABCcd	8,65 \pm 0,07ABCDd
K3	8,15 \pm 0,21Aa	9,18 \pm 0,00Da	8,74 \pm 0,06Ea	9,16 \pm 0,17Aa	8,69 \pm 0,12Cab	8,85 \pm 0,21ABCa	8,20 \pm 0,00Eb
K4	8,15 \pm 0,21Aa	9,28 \pm 0,00Ca	8,93 \pm 0,04BCDEb	8,87 \pm 0,04ABbc	8,87 \pm 0,12BCbc	8,99 \pm 0,12Aab	8,60 \pm 0,00BCDc
K5	8,15 \pm 0,21Aa	9,40 \pm 0,00ABa	9,10 \pm 0,02ABab	8,96 \pm 0,17ABb	8,87 \pm 0,04BCbc	8,59 \pm 0,16BCDcd	8,48 \pm 0,00Dd
K6	8,15 \pm 0,21Aa	9,43 \pm 0,00Aa	8,87 \pm 0,04CDEbcd	9,16 \pm 0,02Aab	8,94 \pm 0,14BCbc	8,45 \pm 0,21Dd	8,54 \pm 0,08CDcd

S1: Natural casings (beef small intestine) without starter culture, S2: Artificial (collagen) case without starter culture, S3:100% cotton case with Ne20 yarn number without starter culture S4:100% cotton case with Ne30 yarn number without starter culture, S5:100% polyester case with Ne20 yarn number without starter culture S6:35% cotton / 65% polyester case with Ne20 yarn number without starter culture, K1: Natural case (intestine) with starter culture, K2: Artificial (collagen) case with starter culture, K3:100% cotton case with Ne20 yarn number with starter culture K4:100% cotton case with Ne30 yarn number with starter culture, K5:100% polyester case with Ne20 yarn number with starter culture K6: 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples (p<0.05).

Results and Discussion

Table 5. **Total yeast & mold counts** during various fermentation and storage stages of sausage samples (log cfu /g)

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	4,92±0,2 Aa	5,75±0,03Ca	5,56±0,07Db	5,35±0,02Dc	5,14±0,03Ed	5,09±0,03Dd	5,23±0,04Ecd
S2	4,92±0,21Aa	4,65±0,03Ea	4,42±0,05EAb	4,37±0,09Fab	4,18±0,00Fb	4,42±0,04Eab	4,59±0,14Fa
S3	4,92± 0,21Aa	6,37±0,05Ad	6,92±0,04Aa	6,57±0,04ABc	6,79±0,00ABab	6,72±0,03Abc	6,94±0,04Aa
S4	4,92±0,21Aa	6,21±0,00Bc	6,82±0,01Aa	6,34±0,11Bbc	6,58±0,03BCab	6,39±0,28ABbc	6,37±0,01BCbc
S5	4,92±0,21Aa	5,83±0,01Cc	6,89±0,06Aa	6,41±0,04ABb	6,78±0,04ABa	5,95±0,01Cc	6,29±0,16BCDbc
S6	4,92±0,21Aa	5,87±0,07Cc	6,66±0,05ABa	6,66±0,08Aa	6,66±0,01Ba	6,58±0,01AAb	6,38±0,00BCb
K1	5,03±0,33Aa	4,58±0,03Eabcd	5,43±0,18Da	4,93±0,06Eb	4,91±0,01Ebc	4,55±0,02Ecd	4,51±0,11Fd
K2	5,03±0,33Aa	4,40±0,04Fb	3,65±0,07Fc	3,50±0,10Gc	3,74±0,20Gc	4,33±0,04Eb	4,41±0,10Fb
K3	5,03±0,33Aa	6,18±0,05Bbc	6,53±0,04Bab	6,41±0,10ABabc	6,66±0,06Ba	6,40±0,05ABabc	6,04±0,20CDc
K4	5,03±0,33Aa	6,17±0,01Bc	6,00±0,04Cc	6,60±0,06ABa	6,38±0,03Cb	6,49±0,04Aab	6,06±0,08CDc
K5	5,03±0,33Aa	6,26±0,04ABd	6,39±0,06Bcd	6,51±0,08ABbc	6,92±0,04Aa	6,67±0,04Ab	6,58±0,05ABbc
K6	5,03±0,33Aa	5,54±0,03Dd	6,45±0,01Ba	6,04±0,01Cb	6,05±0,01Db	6,10±0,02BCb	5,93±0,04Dc

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Results and Discussion

Table 6. **Changes in pH values** during various fermentation and storage stages of sausage samples

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	6,13 ^{±0,07} Aa	5,27 ^{±0,09} Aa	5,11 ^{±0,07} Abb	5,12 ^{±0,05} BCb	5,13 ^{±0,02} ABCb	5,14 ^{±0,01} BCb	5,14 ^{±0,07} ABCDab
S2	6,13 ^{±0,07} Ab	5,16 ^{±0,08} Aab	5,02 ^{±0,06} Abb	5,06 ^{±0,06} BCb	5,05 ^{±0,01} ABCb	5,11 ^{±0,01} BCab	5,09 ^{±0,03} BCDab
S3	6,13 ^{±0,07} Aa	5,25 ^{±0,09} Aa	5,28 ^{±0,22} Aa	5,43 ^{±0,21} Aa	5,36 ^{±0,10} ABa	5,42 ^{±0,01} ABa	5,40 ^{±0,00} Aa
S4	6,13 ^{±0,07} Aa	5,22 ^{±0,09} Aa	5,23 ^{±0,11} Aa	5,29 ^{±0,05} ABa	5,38 ^{±0,21} Aa	5,41 ^{±0,09} ABa	5,30 ^{±0,02} ABCa
S5	6,13 ^{±0,07} Ab	5,21 ^{±0,10} Ab	5,20 ^{±0,06} Abb	5,30 ^{±0,02} ABab	5,35 ^{±0,15} ABab	5,62 ^{±0,18} Aa	5,40 ^{±0,01} Aab
S6	6,13 ^{±0,07} Aa	5,23 ^{±0,11} Aa	5,19 ^{±0,13} Aba	5,31 ^{±0,12} ABa	5,23 ^{±0,08} ABCa	5,29 ^{±0,02} ABCa	5,30 ^{±0,08} ABCa
K1	6,06 ^{±0,063} Aa	5,09 ^{±0,19} Aa	5,05 ^{±0,07} Aba	5,02 ^{±0,11} BCa	4,98 ^{±0,00} BCa	5,03 ^{±0,04} BCa	4,94 ^{±0,09} Da
K2	6,06 ^{±0,063} Aa	5,02 ^{±0,21} Aa	4,92 ^{±0,04} Ba	4,98 ^{±0,01} Ca	4,90 ^{±0,01} Ca	4,93 ^{±0,04} Ca	4,91 ^{±0,05} Da
K3	6,06 ^{±0,063} Aa	5,08 ^{±0,11} Aa	5,07 ^{±0,17} ABa	5,29 ^{±0,16} ABa	5,19 ^{±0,13} ABCa	5,31 ^{±0,09} ABCa	5,37 ^{±0,16} ABa
K4	6,06 ^{±0,063} Ab	5,08 ^{±0,17} Ab	5,05 ^{±0,08} Abb	5,21 ^{±0,07} ABCab	5,17 ^{±0,09} ABCab	5,45 ^{±0,29} ABa	5,39 ^{±0,16} ABab
K5	6,06 ^{±0,063} Ac	5,04 ^{±0,22} Ac	5,12 ^{±0,14} ABbc	5,24 ^{±0,08} ABCabc	5,09 ^{±0,05} ABCc	5,39 ^{±0,10} ABCa	5,39 ^{±0,03} ABab
K6	6,06 ^{±0,063} Aa	5,10 ^{±0,20} Aa	5,07 ^{±0,26} Aba	5,23 ^{±0,32} ABCa	5,09 ^{±0,11} ABCa	5,19 ^{±0,13} ABCa	5,05 ^{±0,03} CDa

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Results and Discussion

Table 7. Changes in **dry matter (%)** and **weight loss** of sausages during various fermentation and storage stages

Sample		Fermentation					Storage		
		0. day	2. day	4. day	6. day	8. day	12. day	18. day	32. day
S1	Dry matter (%)	47,90 ^{±0,14} Ag	54,11 ^{±0,30} ABf	60,62 ^{±0,65} CDEe	66,99 ^{±0,83} CDEd	73,28 ^{±0,68} Abc	77,22 ^{±0,88} BCb	79,82 ^{±0,48} ABCa	77,29 ^{±0,15} Cb
	Weight loss (%)		19,55 ^{±0,05} BCDe	26,90 ^{±0,17} CDEFd	31,73 ^{±0,44} BCDc	34,79 ^{±0,46} BCDEb	38,12 ^{±0,41} BDEa	38,62 ^{±0,43} BCDa	38,69 ^{±0,53} CDEa
S2	Dry matter (%)	47,90 ^{±0,14} Af	54,58 ^{±1,53} ABe	62,73 ^{±1,18} BCd	69,32 ^{±1,01} BCc	73,16 ^{±0,01} Abb	78,94 ^{±0,99} ABa	77,04 ^{±0,14} Ea	78,22 ^{±0,69} ABCa
	Weight loss (%)		19,86 ^{±0,40} ABCDe	27,84 ^{±0,49} ABCDd	33,06 ^{±0,38} ABCc	36,28 ^{±0,33} ABCb	39,58 ^{±0,34} ABCa	39,90 ^{±0,26} ABa	40,15 ^{±0,42} ABa
S3	Dry matter (%)	47,90 ^{±0,14} Ag	51,24 ^{±1,19} Bf	56,77 ^{±0,24} Fe	66,04 ^{±0,21} DEFd	69,92 ^{±0,16} Dc	77,02 ^{±0,25} BCb	80,80 ^{±0,45} Aa	78,48 ^{±0,97} ABCab
	Weight loss (%)		17,22 ^{±0,78} Ee	25,65 ^{±0,21} Fd	30,58 ^{±0,06} Dc	33,78 ^{±0,25} Eb	37,36 ^{±0,26} Dea	37,44 ^{±0,06} Da	38,53 ^{±0,56} CDEa
S4	Dry matter (%)	47,90 ^{±0,14} Ae	54,35 ^{±1,11} ABd	59,21 ^{±0,54} Efc	70,93 ^{±1,31} BCb	72,78 ^{±0,03} ABCb	77,38 ^{±0,82} Bca	78,88 ^{±0,22} BCDEa	78,83 ^{±0,30} ABCa
	Weight loss (%)		21,77 ^{±0,65} Ae	29,71 ^{±0,70} Ad	34,85 ^{±0,84} Ac	37,93 ^{±0,80} Ab	41,28 ^{±0,89} Aa	41,38 ^{±0,71} Aa	41,22 ^{±0,21} Aa
S5	Dry matter (%)	47,90 ^{±0,14} Ae	53,37 ^{±0,29} ABd	61,71 ^{±0,83} BCDEc	74,53 ^{±0,95} Bb	73,63 ^{±1,10} Ab	81,01 ^{±0,35} Aa	79,96 ^{±0,34} ABCa	78,86 ^{±0,03} ABCa
	Weight loss (%)		21,41 ^{±0,13} Abe	29,11 ^{±0,76} Abd	33,65 ^{±0,59} ABc	36,61 ^{±0,52} ABb	39,82 ^{±0,44} ABa	39,47 ^{±0,43} BCa	39,25 ^{±0,16} BCDa
S6	Dry matter (%)	47,90 ^{±0,14} Af	51,44 ^{±1,20} Be	62,80 ^{±0,85} BCd	68,70 ^{±0,14} Ac	73,57 ^{±0,25} Ab	78,02 ^{±0,75} BCa	79,96 ^{±0,58} ABCa	79,23 ^{±0,19} ABCa
	Weight loss (%)		20,40 ^{±0,03} ABCDe	28,32 ^{±0,14} ABCDd	32,99 ^{±0,33} ABCc	35,97 ^{±0,42} ABCdb	39,22 ^{±0,51} BCDa	39,13 ^{±0,63} BCDa	39,82 ^{±0,01} BCa
K1	Dry matter (%)	47,65 ^{±0,07} Af	55,57 ^{±0,42} Ae	60,94 ^{±0,93} BCDEd	67,49 ^{±0,05} BCDc	74,73 ^{±0,74} Ab	79,10 ^{±0,43} Aba	78,28 ^{±0,89} CDEa	79,76 ^{±0,51} ABa
	Weight loss (%)		20,57 ^{±0,75} ABCe	27,74 ^{±0,50} BCDd	31,79 ^{±0,77} BCDc	34,71 ^{±0,72} BCDEb	37,86 ^{±0,54} CDEa	37,84 ^{±0,07} CDa	38,22 ^{±0,25} DEa
K2	Dry matter (%)	47,65 ^{±0,07} Af	56,81 ^{±1,03} Ae	63,41 ^{±0,09} ABd	68,22 ^{±0,33} CDEc	73,65 ^{±1,05} Ab	78,54 ^{±0,48} ABCa	78,77 ^{±0,00} BCDEa	78,36 ^{±0,02} ABCa
	Weight loss (%)		19,59 ^{±0,29} BCDe	27,68 ^{±0,16} BCDEd	32,19 ^{±0,17} BCDc	35,31 ^{±0,13} BCDEb	38,49 ^{±0,13} BCDEa	38,37 ^{±0,08} BCDa	37,94 ^{±0,07} DEa
K3	Dry matter (%)	47,65 ^{±0,07} Ag	55,59 ^{±0,52} Af	60,40 ^{±0,28} CDEe	65,54 ^{±0,10} CDEd	71,16 ^{±0,06} BCDc	78,20 ^{±0,28} BCb	77,60 ^{±0,57} DEb	79,90 ^{±0,42} Aa
	Weight loss (%)		18,74 ^{±0,47} CDEd	26,27 ^{±0,28} DEFc	32,70 ^{±0,15} BCb	34,01 ^{±0,28} Deb	37,41 ^{±0,41} DEa	37,93 ^{±0,44} CDa	37,87 ^{±0,05} Ea
K4	Dry matter (%)	47,65 ^{±0,07} Af	55,52 ^{±0,52} Ae	60,00 ^{±0,17} Ded	66,29 ^{±0,40} Efc	73,63 ^{±0,10} Ab	78,12 ^{±0,45} BCa	77,06 ^{±0,45} Ea	77,82 ^{±0,82} Bca
	Weight loss (%)		19,62 ^{±0,84} BCDe	27,22 ^{±0,46} BCDEFd	31,92 ^{±0,48} BCDc	35,13 ^{±0,51} BCDEb	38,48 ^{±0,40} BCDEa	38,53 ^{±0,27} BCDa	38,21 ^{±0,53} DEa
K5	Dry matter (%)	47,65 ^{±0,07} Ae	54,77 ^{±0,86} ABd	65,80 ^{±0,94} Ac	66,86 ^{±0,92} Dec	70,54 ^{±0,81} CDb	76,10 ^{±0,85} Ca	78,97 ^{±0,22} ABCDa	78,51 ^{±0,65} ABCa
	Weight loss (%)		19,38 ^{±0,69} BCDe	26,94 ^{±0,90} CDEFd	31,28 ^{±0,73} CDc	34,38 ^{±0,89} CDEb	37,75 ^{±0,71} CDEa	37,88 ^{±0,87} CDa	38,63 ^{±0,13} CDEa
K6	Dry matter (%)	47,65 ^{±0,07} Af	55,43 ^{±0,64} Ae	62,54 ^{±0,09} BCDd	63,45 ^{±0,07} CDEd	73,25 ^{±0,28} Abc	78,12 ^{±0,74} BCb	80,58 ^{±0,53} Aba	78,45 ^{±0,05} ABCb
	Weight loss (%)		18,36 ^{±0,29} Def	25,77 ^{±0,00} Efe	30,36 ^{±0,03} Dd	33,40 ^{±0,11} Ec	36,79 ^{±0,11} Eb	37,52 ^{±0,29} Db	38,46 ^{±0,39} DEa

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples (p<0.05).

Results and Discussion

Table 8. **TBA contents** of sausage samples during various fermentation and storage stages (mg ma/kg)

Sample	Fermentation				Storage	
	0. day	4. day	6. day	12. day	18. day	32. day
S1	0,45±0,07Aa	0,86±0,01Aa	0,66±0,01Eb	0,58±0,01BCb	0,56±0,06ABCDb	0,55±0,06BCDb
S2	0,45±0,07Aa	0,68±0,01Dea	0,65±0,01Fa	0,53±0,03Cbc	0,62±0,05Aab	0,48±0,04Dc
S3	0,45±0,07Aa	0,76±0,01Bca	0,75±0,00Ca	0,64±0,03ABab	0,60±0,06ABb	0,58±0,01ABCDb
S4	0,45±0,07Aa	0,67±0,00Eb	0,79±0,00Ba	0,68±0,05Ab	0,50±0,02BCDc	0,50±0,02Dc
S5	0,45±0,07Aa	0,69±0,01Dea	0,63±0,00Gab	0,60±0,01ABCab	0,53±0,06ABCDb	0,67±0,05Aa
S6	0,45±0,07Aa	0,75±0,01Ca	0,78±0,00Ba	0,65±0,04ABab	0,53±0,03ABCDb	0,53±0,07BCDb
K1	0,47±0,01Aa	0,76±0,02Bca	0,63±0,01Gab	0,60±0,02ABCbc	0,48±0,07Dc	0,54±0,02BCDbc
K2	0,47±0,01Aa	0,76±0,01Bca	0,71±0,00Dab	0,60±0,06ABCbc	0,62±0,05Aabc	0,51±0,04CDc
K3	0,47±0,01Aa	0,71±0,00Dab	0,82±0,00Aa	0,63±0,08ABb	0,63±0,01Aab	0,64±0,07ABab
K4	0,47±0,01Aa	0,68±0,00Dea	0,66±0,01Ea	0,59±0,05ABCab	0,48±0,06CDb	0,61±0,04ABCab
K5	0,47±0,01Aa	0,78±0,01Ba	0,67±0,00Eab	0,66±0,06ABab	0,59±0,02ABCb	0,54±0,06BCDb
K6	0,47±0,01Aa	0,69±0,00Deab	0,75±0,00Ca	0,64±0,02ABab	0,59±0,07ABCb	0,59±0,10ABCDb

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Results and Discussion

Table 9. Changes in L^* values of sausage samples during various fermentation and storage stages

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	46,63 ^{±0,63} Aab	44,66 ^{±0,29} CDb	45,28 ^{±1,24} Dab	44,83 ^{±0,74} CDb	45,46 ^{±0,55} BCDab	44,63 ^{±1,00} Cb	46,95 ^{±0,35} ABCDa
S2	46,63 ^{±0,63} Aabc	45,16 ^{±1,05} BCDbc	47,48 ^{±1,02} ABCab	46,23 ^{±0,20} ABCDabc	45,06 ^{±0,32} CDc	44,56 ^{±1,00} Cc	47,53 ^{±1,16} ABCa
S3	46,63 ^{±0,63} Aab	45,18 ^{±0,77} BCDb	47,55 ^{±0,25} ABab	45,04 ^{±1,22} BCDb	46,51 ^{±1,76} ABCab	45,09 ^{±0,56} BCb	48,38 ^{±0,22} Aa
S4	46,63 ^{±0,63} Aa	46,33 ^{±0,93} Aba	45,93 ^{±0,41} CDa	44,48 ^{±0,52} Da	45,23 ^{±0,52} BCDa	44,54 ^{±0,35} Ca	45,22 ^{±1,53} Da
S5	46,63 ^{±0,63} Aab	45,94 ^{±0,46} ABCab	46,23 ^{±0,59} BCDab	46,28 ^{±0,18} ABCDab	45,47 ^{±1,13} BCDb	45,26 ^{±0,85} BCb	47,62 ^{±0,92} ABa
S6	46,63 ^{±0,63} Aab	44,23 ^{±1,50} Db	48,55 ^{±1,92} Aa	46,62 ^{±0,86} ABCDab	46,73 ^{±0,95} Abab	45,58 ^{±0,21} BCab	47,44 ^{±0,21} ABCa
K1	47,46 ^{±1,65} Aa	46,07 ^{±0,60} ABCa	47,40 ^{±0,45} ABCa	46,20 ^{±0,09} ABCDa	45,57 ^{±0,13} ABCDa	46,53 ^{±0,67} ABa	45,46 ^{±0,25} CDa
K2	47,46 ^{±1,65} Aa	45,38 ^{±0,78} ABCDb	47,35 ^{±0,07} ABCa	47,28 ^{±0,69} ABCa	45,48 ^{±1,70} BCDb	45,41 ^{±0,20} BCb	45,39 ^{±0,18} CDb
K3	47,46 ^{±1,65} Aa	46,91 ^{±1,91} Aa	47,30 ^{±1,15} ABCa	48,65 ^{±1,28} Aa	47,13 ^{±0,93} Aa	48,04 ^{±0,08} Aa	48,04 ^{±0,08} Aa
K4	47,46 ^{±1,65} Aa	45,23 ^{±0,73} BCDc	46,35 ^{±0,13} BCDabc	47,33 ^{±0,60} ABab	44,94 ^{±0,74} CDc	45,36 ^{±0,86} BCc	45,75 ^{±1,16} BCDbc
K5	47,46 ^{±1,65} Aabc	45,92 ^{±0,46} ABCc	47,83 ^{±1,47} ABab	48,04 ^{±1,50} Aa	46,06 ^{±0,41} ABCDbc	46,24 ^{±0,08} ABCabc	45,83 ^{±0,32} BCDc
K6	47,46 ^{±1,65} Aa	45,57 ^{±0,99} ABCDb	48,14 ^{±0,56} Aa	47,57 ^{±0,77} Aa	44,57 ^{±0,64} Db	44,90 ^{±0,57} BCb	45,12 ^{±0,43} Db

S1: Natural casings (beef small intestine) without starter culture, S2: Artificial (collagen) case without starter culture, S3: 100% cotton case with Ne20 yarn number without starter culture S4: 100% cotton case with Ne30 yarn number without starter culture, S5: 100% polyester case with Ne20 yarn number without starter culture S6: 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, K1: Natural case (intestine) with starter culture, K2: Artificial (collagen) case with starter culture, K3: 100% cotton case with Ne20 yarn number with starter culture K4: 100% cotton case with Ne30 yarn number with starter culture, K5: 100% polyester case with Ne20 yarn number with starter culture K6: 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Results and Discussion

Table 10. Changes in a^* values of sausage samples during various fermentation and storage stages

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	8,91±0,06Ac	12,87±0,09Aa	12,43±0,72Aab	11,69±0,38Aab	11,47±0,43Ab	9,95±0,52Ac	8,57±0,45ABCDd
S2	8,91±0,06Ac	13,02±0,72Aa	11,31±0,21ABCb	11,40±0,02ABb	10,76±0,40Abb	9,49±0,36ABc	8,92±0,11ABc
S3	8,91±0,06Ac	12,54±0,48Aa	10,33±0,14BCb	10,68±0,49ABb	8,36±0,92Dec	8,68±0,42BCc	7,93±0,19BCDEc
S4	8,91±0,06Abcd	11,33±0,35Aa	10,47±0,27Bcab	9,40±1,54Bbc	7,88±0,65Ecd	7,48±0,17Ed	7,45±0,25Ed
S5	8,91±0,06Ac	11,85±0,18Aa	11,57±0,24ABCab	10,15±1,14ABbc	8,46±0,88CDEde	7,15±0,48Ee	7,34±0,20Ede
S6	8,91±0,06Ac	11,85±0,18Aa	10,27±0,16Cb	10,18±0,40ABb	9,44±0,05BCDEc	8,75±0,12BCd	7,91±0,13CDEc
K1	8,79±0,31Ab	11,22±0,53Aa	11,15±0,45ABCa	10,40±0,08ABa	10,51±0,51Aba	9,21±0,15ABCb	8,74±0,64ABCb
K2	8,79±0,31Ad	12,14±0,34Aa	11,58±0,30ABCab	10,34±1,00ABbc	10,21±0,57ABCbc	9,34±0,21ABcd	8,98±0,27Ac
K3	8,79±0,31Ac	11,60±0,58Aa	11,91±1,00Aa	11,06±0,15ABab	9,82±0,21ABCDBC	7,07±0,11Ed	6,99±0,21EFd
K4	8,79±0,31Ac	12,22±0,61Aa	11,61±0,24Abab	10,51±0,57ABb	9,13±0,49BCDEc	7,80±0,09DEd	8,53±0,32ABCDCd
K5	8,79±0,31Ac	12,92±0,27Aa	11,32±0,39ABCb	10,87±0,67ABb	9,95±0,96ABCDBC	9,12±0,05ABCcd	7,74±0,34DEd
K6	8,79±0,31Ac	13,65±0,70Aa	11,13±0,43ABCb	10,85±0,20ABb	9,37±0,56BCDEc	8,42±0,31CDc	6,14±0,51Fd

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Results and Discussion

Table 11. Changes in b^* values of sausage samples during various fermentation and storage stages

Sample	Fermentation					Storage	
	0. day	2. day	4. day	6. day	12. day	18. day	32. day
S1	20,54±0,55Aa	15,65±0,08Abb	14,10±0,67Ac	13,66±0,37Acd	12,96±0,58Acd	12,57±0,03Ad	13,03±0,35Acd
S2	20,54±0,55Aa	15,57±0,39Abb	13,59±0,27Abc	13,58±0,19Acd	12,41±0,45ABde	11,93±0,60ABCe	13,05±0,34Acde
S3	20,54±0,55Aa	15,26±0,70ABCb	13,03±0,18Abc	12,47±0,41ABCcd	12,69±0,38ABcd	12,16±0,13ABc	12,76±0,18ABc
S4	20,54±0,55Aa	14,43±0,40BCb	12,91±0,44Abbc	10,86±1,32Cd	11,37±0,85ABCcd	11,04±0,38BCDcd	11,86±0,43ABCcd
S5	20,54±0,55Aa	14,65±0,39BCb	14,10±0,27Abc	11,98±1,06ABCd	11,48±1,06ABCd	11,78±0,10ABCd	12,33±0,28ABCcd
S6	20,54±0,55Aa	16,17±0,68Ab	12,51±0,75Bc	11,75±0,13BCc	11,25±0,16ABCc	11,80±0,13ABCc	11,95±0,29ABCc
K1	20,45±0,27Aa	13,88±0,76Cb	13,18±0,13Abbc	11,11±0,23Cde	12,01±0,16ABcd	10,15±0,73De	10,80±1,12Cde
K2	20,45±0,27Aa	14,39±0,18BCb	12,92±0,24Abc	10,88±0,46Cd	11,16±0,52BCd	10,26±0,30Dd	11,42±0,87ABCd
K3	20,45±0,27Aa	13,83±0,22Cb	12,74±0,58Bbc	12,83±0,59ABbc	11,51±0,57ABCc	12,66±0,24Abc	11,51±0,87ABCc
K4	20,45±0,27Aa	14,54±0,89BCb	13,30±0,63Abbc	11,86±0,23BCcd	10,02±0,85Ce	11,15±0,68BCDde	11,53±0,46ABCde
K5	20,45±0,27Aa	15,72±0,23Abb	12,94±0,45Abc	11,82±0,20BCd	11,82±0,17ABd	11,51±0,13ABCd	11,23±0,38BCd
K6	20,45±0,27Aa	15,38±0,32Abb	12,89±0,24Abc	12,06±0,37ABCcd	11,29±0,61ABCde	10,83±0,51CDe	11,28±0,54BCde

S1: Natural casings (beef small intestine) without starter culture, **S2:** Artificial (collagen) case without starter culture, **S3:** 100% cotton case with Ne20 yarn number without starter culture **S4:** 100% cotton case with Ne30 yarn number without starter culture, **S5:** 100% polyester case with Ne20 yarn number without starter culture **S6:** 35% cotton / 65% polyester case with Ne20 yarn number without starter culture, **K1:** Natural case (intestine) with starter culture, **K2:** Artificial (collagen) case with starter culture, **K3:** 100% cotton case with Ne20 yarn number with starter culture **K4:** 100% cotton case with Ne30 yarn number with starter culture, **K5:** 100% polyester case with Ne20 yarn number with starter culture **K6:** 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day, while lower case letters denote the statistical difference between the values of different days on the same sample. Different letters indicate a statistically significant difference between samples ($p < 0.05$).

Results and Discussion

Table 12. **Sensory analysis** of cooked and uncooked sausage samples at the end of the storage time

Sample		Color of cross section	Outside appearance	Texture	Aroma and taste	Skin formation	Overall acceptance
S1	Uncooked	7,6 ^{±0,55} ABCD	7,8 ^{±0,84} BC	8 ^{±0,98} A	7,8 ^{±0,84} A	7,6 ^{±0,55} A	7,36 ^{±0,49} BC
	Cooked	7,4 ^{±0,55} ABC	8,0 ^{±0,84} ABC	8,0 ^{±0,71} A	8,0 ^{±0,71} AB	n.a	7,6 ^{±0,55} BCD
S2	Uncooked	7,8 ^{±0,84} ABC	8,6 ^{±0,55} A	7,2 ^{±1,03} AB	7,8 ^{±0,84} A	7,2 ^{±1,30} AB	7,77 ^{±0,44} AB
	Cooked	7,2 ^{±0,45} ABCD	8,6 ^{±0,55} A	8,4 ^{±0,55} A	8,2 ^{±0,45} A	n.a	8,2 ^{±0,45} ABC
S3	Uncooked	5,6 ^{±0,55} F	3,8 ^{±0,45} G	6,0 ^{±1,41} BC	6,6 ^{±0,55} ABC	5 ^{±0,71} C	5,30 ^{±0,84} E
	Cooked	5,2 ^{±0,84} E	5,8 ^{±0,84} DE	5,2 ^{±0,84} D	6,4 ^{±0,55} DE	n.a	6,0 ^{±0,71} E
S4	Uncooked	6,8 ^{±0,45} DE	4,8 ^{±0,45} F	6,0 ^{±1,17} BC	7,4 ^{±0,89} AB	6,0 ^{±1,22} ABC	6,25 ^{±0,43} D
	Cooked	6,0 ^{±0,71} CDE	6,0 ^{±0,71} DE	6,6 ^{±0,55} B	6,8 ^{±0,84} CDE	n.a	6,6 ^{±0,55} DE
S5	Uncooked	7,0 ^{±1,22} CDE	5 ^{±0,00} EF	5,6 ^{±1,21} C	6,2 ^{±0,84} BC	6,4 ^{±0,55} ABC	6,19 ^{±0,45} D
	Cooked	5,8 ^{±0,45} DE	6,6 ^{±0,55} CDE	6,2 ^{±0,45} BC	6,2 ^{±0,45} E	n.a	6,8 ^{±0,45} DE
S6	Uncooked	6,4 ^{±0,89} EF	5,8 ^{±0,84} D	5,4 ^{±1,03} C	7,6 ^{±0,55} A	7,4 ^{±0,55} A	6,26 ^{±0,83} D
	Cooked	5,8 ^{±0,84} DE	5,8 ^{±0,45} DE	5,4 ^{±0,55} CD	7,2 ^{±0,84} ABCDE	n.a	6,8 ^{±0,45} DE
K1	Uncooked	7,8 ^{±0,84} ABC	7,6 ^{±0,55} C	8,2 ^{±0,63} A	7,6 ^{±1,95} A	7,6 ^{±0,89} A	7,96 ^{±0,72} AB
	Cooked	7,0 ^{±0,71} BCD	8,4 ^{±0,55} AB	8,0 ^{±0,71} A	7,4 ^{±1,34} ABCD	n.a	8,4 ^{±0,55} AB
K2	Uncooked	8,0 ^{±0,71} AB	8,4 ^{±0,55} AB	8,2 ^{±0,89} A	7,6 ^{±1,95} A	7,8 ^{±0,84} A	8,21 ^{±0,45} A
	Cooked	7,8 ^{±0,45} AB	8,4 ^{±0,55} AB	8,6 ^{±0,55} A	7,6 ^{±1,52} ABC	n.a	9,0 ^{±0,00} A
K3	Uncooked	8,4 ^{±0,55} A	5,6 ^{±0,55} DE	6,4 ^{±1,51} BC	7,2 ^{±0,84} ABC	6,8 ^{±0,84} ABC	6,98 ^{±0,71} C
	Cooked	8,6 ^{±0,55} A	7,0 ^{±0,71} BCD	6,8 ^{±1,30} B	7,0 ^{±0,71} BCDE	n.a	7,2 ^{±0,45} CD
K4	Uncooked	7,6 ^{±0,55} ABCD	5,8 ^{±0,84} D	6 ^{±0,75} BC	6,0 ^{±0,71} C	5,4 ^{±1,14} BC	6,27 ^{±0,44} D
	Cooked	6,4 ^{±0,55} BCDE	6,6 ^{±0,55} CDE	6,6 ^{±0,55} B	7,0 ^{±0,71} BCDE	n.a	7,0 ^{±0,45} DE
K5	Uncooked	7,4 ^{±0,55} BCD	5,6 ^{±0,55} DE	6,4 ^{±1,21} BC	6,0 ^{±0,71} C	6,6 ^{±0,55} ABC	6,27 ^{±0,44} D
	Cooked	5,8 ^{±0,84} DE	6,4 ^{±0,55} DE	6,2 ^{±0,84} BC	6,6 ^{±0,55} CDE	n.a	6,8 ^{±0,45} DE
K6	Uncooked	6,4 ^{±0,89} EF	6,0 ^{±0,71} D	6,2 ^{±0,82} BC	6,0 ^{±1,00} C	6,8 ^{±0,84} ABC	6,03 ^{±0,71} DE
	Cooked	5,4 ^{±0,89} E	5,4 ^{±1,14} E	5,4 ^{±0,55} CD	7,4 ^{±0,89} ABCD	na.	6,6 ^{±0,55} DE

S1: Natural casings (beef small intestine) without starter culture, S2: Artificial (collagen) case without starter culture, S3:100% cotton case with Ne20 yarn number without starter culture S4:100% cotton case with Ne30 yarn number without starter culture, S5:100% polyester case with Ne20 yarn number without starter culture S6:35% cotton / 65% polyester case with Ne20 yarn number without starter culture, K1: Natural case (intestine) with starter culture, K2: Artificial (collagen) case with starter culture, K3:100% cotton case with Ne20 yarn number with starter culture K4:100% cotton case with Ne30 yarn number with starter culture, K5:100% polyester case with Ne20 yarn number with starter culture K6: 35% cotton / 65% polyester case with Ne20 yarn number with starter culture. Uppercase letters represent the statistical difference between the different samples on the same day. Different letters indicate a statistically significant difference between samples (p<0.05).

To sum up

- It was determined that the **same filling method applied** to natural and artificial casing, which did not have any problem during the filling of the sausage dough, so the traditional **method could be applied successfully to the textile based casings**.
- The lukewarm water soaking process applied to the natural and artificial casings prior to filling was also applied to the textile casings, and during filling, **the spices found** in the sausage paste were **dissolved in the water and which was held by the fabric, resulted in changes in the color of the casing**.
- In both S and K groups, it was observed that **the samples made with various fabrics** (S3, S4, S5, S6, K3, K4, K5, K6) **had higher pH values** than the samples made of artificial and natural casings (S1, S2, K1, K2) during fermentation and storage periods.
- Dry matter content (76.10%) observed in the K5 sample was significantly lower than that of the other sample groups. It was seen that **the use of fabrics** with different type and **structure had a significant effect on weight loss**.
- When the color values of the sausage samples were examined: the highest L^* values were in sausage samples with a gauze like muslin casings (S3, K3). Again, the samples of natural (S1, K1) and artificial (S2, K2) sheathed sausages had a higher a^* value than the samples with fabric casings (S3, S4, S, S6, K3, K4, K5, K6). The b^* value of the all samples decreased during the fermentation (day 0-12). The lowest b^* value was observed in K4 sample and the highest b^* value was observed in S1 sample on 12th day.
- **S: WO starter, K: W starter**

To sum up (Cont.)

- The lowest TBA values of both S and K groups were found in the artificial casings (S2, K2). It was also observed that the fabric thread density had an effect on the TBA value.
- An increase was observed in the number of total mesophilic aerobic bacteria (TMAB) during the fermentation period (day 0-12), while a decrease was observed in the number of TMAB during the storage period (12-32 days). On day 12 of fermentation the number of TMAB of the fabric sheathed samples was higher than the natural and artificial sheathed samples.
- Among the S samples, it was seen that the LAB of fabric-coated sausage samples showed higher number than that of the natural and artificial sheathed samples, whereas among the K-group samples, the LAB number of the natural and artificial sheathed samples was higher than that of the fabric-coated samples.
- On day 32 of storage the total number of yeast and molds of the samples was in the range of 4.41-6.94 log cfu/g, where it was significantly higher in fabric sheathed sausages than in the natural and artificial sheathed samples.
- According to the results of sensory analysis, K2 sample [collagen casing with starter culture] was the favorite sausages, while K3 [100% cotton case with NE20 yarn number with starter culture] sample was the most preferred cloth casing among the sausages.
- S: WO starter, K: W starter

Thanks for your attention!



