



Effects of Different Humectants in the Physico-Chemical Properties of Ready-to-Eat (RTE) Tocino

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Abstract: This study was conducted to determine the effects of humectants in the physico-chemical properties of RTE dried tocino. The study was divided into three phases that involved standardization of procedure for dried tocino, determination of the effects of varying levels of different humectants on RTE dried tocino, and determination of appropriate drying time. Water activity (A_w), moisture content analyses, sensory evaluation, and statistical analysis were done. Hedonic Rating Scale and Multiple Comparison Tests were the methods used in Sensory Evaluation. Data gathered from the results were tabulated, analyzed and interpreted using Anova. The most acceptable RTE dried tocino underwent microbiological and nitrate content analyses.

Based on the results of A_w analysis, RTE dried tocino with 2.5%-7.5% glycerol ranges from 0.767-0.813; with propylene glycol, A_w ranges from 0.782-0.80; and with sorbitol, the A_w ranges from 0.814 to 0.842. The moisture content of RTE dried tocino with 2.5%-7.5% glycerol ranges from 22.802% to 25.48%; with propylene glycol, it ranges from 26.38%-27.69%. The results of sensory evaluation showed that RTE dried tocino with 2.5%-7.5% glycerol and sorbitol were acceptable in terms of color, flavor, and general acceptability. Propylene glycol was unacceptable at all levels. RTE dried tocino with propylene glycol is significantly different from RTE dried tocino with glycerol, sorbitol, and without humectants in terms of color, flavor, and general acceptability.

RTE tocino dried at different drying time has A_w that ranges from 0.783-0.886 and moisture content that ranges from 21.336%-36.000%. Based on Sensory Evaluation, RTE dried tocino at 1.5 hours is the most acceptable to the sensory panels. Microbial analysis of the most acceptable product revealed that RTE dried tocino has aerobic plate count of 3 cfu/g; negative for yeast and molds, *S. aureus* and *E. coli*. There was no nitrate residue found in the most acceptable RTE dried tocino.

Key Words: RTE dried tocino; humectants; Water activity; moisture content; sensory evaluation

1. INTRODUCTION

Ready-to-eat (RTE) food has been described by Tsang (2002), as foods that can be consumed immediately without further heat treatment upon

purchasing. These food products are becoming in demand not only locally but also around the globe. The most popular types of RTE meal are main course substitutes wherein RTE meat belongs. (ACNielsen, 2006).

RTE meat can be classified as: non-shelf-stable, which must be refrigerated prior consumption



to avoid spoilage and growth of pathogenic microorganism; and shelf – stable, which remain safe under room temperature (FSIS, 2001).

One of the popular Filipino meat products that can be processed into a shelf –stable RTE meat product is tocino. Locally, it is known as a ready-to-cook meal commonly prepared from boneless pork treated with salt, sugar, saltpeter, ascorbic acid, and red food color (EMU, 2004). Tocino requires refrigeration or freezing temperature condition to prolong its shelf-life which is commonly neglected by vendors. Once it is left unrefrigerated, pathogenic microorganisms can grow on the product, and the health of the consumers may be at stake.

To answer the agony of the consumers related to improper storage of tocino, the researcher has decided to develop a more stable product ready-to-eat tocino, and this can be done through drying.

In physical terms, drying of meat and meat products is also known as lowering the water activity (A_w) which is essential in lowering the growth of microorganisms. Drying of meat, even though provides a great advantage in making the product shelf stable, may cause some changes on its physical appearance and sensory properties. In order to lessen some of its limitation, incorporation of food additives that will make the product looks moist even if it is dry is recommended and it can be attained through the use of humectants. (Heinz and Hautzinger, 2007). Humectants are substances added in food to promote retention of moisture. Three of the most popular and most commonly used humectants for dried meat are glycerol, propylene glycol, and sorbitol (BFAD, 1984).

This study was conducted to determine the effect of different humectants such as glycerol, propylene glycol, and sorbitol in the development of RTE dried tocino by looking into its physico-chemical and microbiological properties.

2. METHODOLOGY

This study was divided in to three phases. Phase 1 focused on the standardization of the procedure for dried tocino. Phase 2 was engaged in the determination of the effect of varying concentration of glycerol, propylene glycol, and sorbitol on RTE dried tocino. Phase 3 dealt with the determination of appropriate drying time for the most acceptable RTE dried tocino.

2. 1. Phase 1 –Standardization of Procedure for Dried Tocino

2.1.1. Preparation of Ingredients

The main ingredient for this study is the pork shoulder (kasim and paypay), which was purchased from Makeneng Market in Caloocan City. The meat was trimmed, washed and sliced thinly with the thickness of 0.5 cm. Curing ingredients were obtained from Spices and Food Mix House, Lemon Square Bldg., Quezon City. Other ingredients such as refined sugar and pineapple juice were acquired from Super Market in Valenzuela City. All the ingredients that were used were weighed.

2.1.2. Curing and Cooking of Tocino

Curing salt (1.8 g), phosphate (3g), and salt (32g) were first dissolved in water (60 ml) and then mixed with the meat (1000g). The rest of the ingredients such as refined sugar (180g), anisado wine (20g) and pineapple juice (60g) were then added and mixed together till well blended. The mixtures were cured at refrigerated temperature for 1 - 3 days. After the curing period, tocino was cooked by boiling in a small amount of water (8 ml of water was added for every 100 g of tocino). This was cooked for 10 minutes or until meat was tender. (Santos-Rivera, 1993).

2.1.3. Dehydration of Tocino

The cooked tocino were arranged in screen rack and dried in the oven at 100°C for 1 ½ - 2 hours. It were then packed in polyethylene (PE) bags and set aside for sensory evaluation and moisture content analysis.

2.1.4. Evaluation of Dried Tocino

2.1.4. a. Sensory Evaluation

Fifteen (15) untrained panelists evaluated the sensory characteristics as to color, texture, and flavor of the samples using Multiple Comparison Method and the general acceptability using 9-point Hedonic Rating Scales (Gatchalian, M., & Brannan, G., 2009) as shown in Table 1 and 2 respectively.

2. 1. 4. b. Moisture analysis

Electronic Moisture Meter (KER MLB_N Version 2.0) was utilized in determining the moisture content

Table 1. Range Scale Used for the Mean Score of Multiple Comparison Method

Rating Score	Magnitude Equivalent	Equivalent Rate
1-	(1.00 – 1.88)	Extremely Better than R
2-	(1.89 – 2.77)	Much Better than R
3-	(2.78 – 3.66)	Moderately Better than R
4-	(3.67 – 4.55)	Slightly Better than R
5-	(4.56 – 5.44)	Equal to R
6-	(5.45 – 6.33)	Slightly Inferior to R
7-	(6.34 – 7.22)	Moderately Inferior to R
8-	(7.23 – 8.11)	Much Inferior to R
9-	(8.12 – 9.00)	Extremely Inferior to R

Table 2. Range Scale used for the mean score of 9 – point Hedonic Rating Scale

Rating Score	Magnitude Equivalent	Equivalent Rate
9-	(8.12 – 9.00)	Like Extremely
8-	(7.23 – 8.11)	Like Very Much
7-	(6.44 – 7.22)	Like Moderately
6-	(5.45 – 6.33)	Like Slightly
5-	(4.56 – 5.44)	Neither Like Nor Dislike
4-	(3.67 – 4.55)	Dislike Slightly
3-	(2.78 – 3.66)	Dislike Moderately
2-	(1.89 – 2.77)	Dislike Very Much
1-	(1.00 – 1.88)	Dislike Extremely

2.2. Phase 2 – Determination of the Effect of Different Humectants (glycerol, propylene glycol, sorbitol) with Varying Levels of Concentration on RTE Dried Tocino

The established procedure of dried tocino in Phase 1 was used as a reference for Phase 2. The preparation, curing, and cooking of tocino conducted in this phase was similar to Phase 1.

2.2.1. Addition of Different Humectants into Tocino with Varying Levels of Concentrations

Prior to drying, different humectants such as glycerol, propylene glycol, and sorbitol with varying concentrations of 2.5%, 5%, and 7.5% each were added in cooked tocino. 0% served as the control.

2.2.2. Dehydration of Tocino

All samples of tocino with different formulations were dried in the oven for 1 ½ hours at constant temperature of 100° C.

2.2.3. Evaluation and Analysis of Resulting RTE Dried Tocino

2.2.3. a. Aw and Moisture content Analysis

The Aw was determined using the Novasina Water Activity Center Mode RTD 502, while the moisture content was determined using the KER MLB_N Version 2.0 Electronic Moisture Meter. These analyses were conducted at the food testing laboratory of ITDI, DOST in Taguig City and Fitrite Incorporated in Quezon City respectively.

2.2.3 b. Sensory Evaluation

The sensory evaluation procedure was similar to the method presented in subsection 2.1.4.a.

2.3. Phase 3. Determination of Appropriate Drying time for RTE Dried Tocino

2.3.1. Use of Varying Drying Time

The most acceptable RTE dried tocino in Phase 2 was subjected to different drying time specifically 1 hour, 1 ½ hours, and 2 hours at constant temperature of 100°C.

2.3.2. Evaluation and Analysis of Resulting RTE Dried Tocino

The procedures for these analyses were the same with the analyses that were used in Phase 1 and Phase 2.

Test for the most acceptable product were conducted, such as:

2.3.2. a. Microbiological Analysis (*Total Plate Count, Molds and Yeasts Count, and Staphylococcus aureus count*)

The most acceptable RTE dried tocino from sensory evaluation was subjected to microbiological analysis specifically total plate count, molds and yeasts count, *Staphylococcus aureus*, and *Escherichia coli* count which were done at the Microbiology Laboratory at Fitrite Incorporated in Caloocan City.

2.3.2. b. Nitrate Content Analysis

Nitrate content analysis was conducted on the most acceptable product. It was accomplished at Intertek Testing Services Philippines Inc., in Makati



City using Xylenol Method (A.O.A.C., Official Methods of Analysis, 18th Ed., 2005).

2.4. Statistical Treatment of Data

For phase 1, mean scores became the basis to determine the acceptable dried tocino in terms of sensory characteristics as perceived by the panelists. For phases 2 and 3, one way analysis of variance (ANOVA) was utilized to determine the significant differences of color, texture, taste, and general acceptability at 5% level of significance. Duncan Multiple Range Test (DMRT) was used as a post hoc analysis of this study for the result in ANOVA that showed significant differences.

3. RESULTS AND DISCUSSION

3.1. Phase 1 - Standardization of Procedure for Dried Tocino

3.1.1. Sensory Evaluation

Table 3. Mean Scores for the Color, Texture, Flavor, and General Acceptability of Dried Tocino

Sensory Attributes	Different drying time	
	1 ½ hours	2 hours
Color	7.07	7.87
Texture	6.40	6.40
Flavor	6.93	6.73
General Acceptability	7.00	6.53

Given the results of sensory evaluation of dried tocino in Table 3, color of tocino dried for 2 hours is preferred by the panelist over tocino dried for 1 ½ hours. This may be due to color improvement from pale to dark red color at 2 hours drying time. For texture, flavor, and general acceptability, both tocino dried for 1 ½ hours and 2 hours obtained an average rating of “like moderately”. This shows that drying time of 1 ½ to 2 hours do not affect the texture, flavor, and general acceptability of dried tocino as perceived by the panelists.

3.1.2. Moisture Content Analysis

Moisture content of tocino dried for 1 ½ and 2 hours are 23.205% and 18.597% respectively which were both within the range/limit of 15 – 30% for dried meat (Hyman, L. 1975). This suggests that

both drying time were acceptable in producing RTE dried tocino.

Tocino dried for 1 ½ hours was used as reference in succeeding phases since drying for 2 hours would cause higher energy cost and higher weight loss.

3. 2. Phase 2 - Determination of the Effect of Different Humectants (glycerol, propylene glycol, sorbitol) with Varying Levels of Concentration on RTE Dried Tocino

3.2.1. Physico – chemical Analyses

Based from the results presented in Table 4, use of different levels of different humectants has no mark influence on the Aw of the RTE dried tocino. This is further affirmed that Aw falls within the standards for dried meat.

For moisture content analysis, the use of different levels of different humectants increased the moisture content of the RTE dried tocino. In effect, this is evident of the role or functions of humectants in dried foods of retaining and equalizing the moisture content. However, sorbitol has the maximum effect of increasing the moisture content. This confirmed the previous study that moisture content of dried foods was improved while lowering the Aw with the addition of humectants. Moreover, all samples met the required amount range for Aw and moisture content.

Table 4. Aw and Moisture Content Analyses of RTE Dried Tocino with Varying Types and Concentrations of Humectants

Samples	Concen- trations	Aw	Moisture Content
Glycerol	2.5%	0.813	23.870%
	5.0%	0.767	22.802%
	7.5%	0.782	25.480%
Propylene Glycol	2.5%	0.782	22.189%
	5.0%	0.800	25.274%
	7.5%	0.790	23.432%
Sorbitol	2.5%	0.841	26.741%
	5.0%	0.842	27.690%
	7.5%	0.814	26.380%
Control (R)	0%	0.819	18.700%
		Standards: ≤ 0.85**	Limits for dried meat: 15 – 30 %*

**New Zealand Food Safety Authority. (2009); *Hyman, L. (1975)

3. 2. 2. Sensory Evaluation

3.2. 2. a. Sensory evaluation of RTE dried tocino with different types and amount of humectants.

Table 5. Mean Scores for Color, Texture, Flavor, and General Acceptability of RTE Dried Tocino with Varying Amount of Glycerol

Sensory Attributes	Different Concentrations of Glycerol			
	2.5%	5%	7.5%	0% (R)
*Color	4.33 ^a	4.67 ^a	5.13 ^a	
*Texture	5.33 ^b	5.40 ^b	5.20 ^b	
*Flavor	4.07 ^c	4.73 ^c	4.87 ^c	
**General Acceptability	7.60 ^d	6.93 ^d	6.87 ^d	7.4 ^d

*Multiple Comparison Method, **Hedonic Rating Scale
Note: Means having the different letters within the same row differ significantly at $p < 0.05$

Glycerol

Mean scores for color, texture, and flavor of RTE dried tocino with 2.5% - 7.5 %, as shown in Table 5, have an equivalent rating of “slightly better than R”, to “equal to R”, while the general acceptability obtained an equivalent rating of “like moderately” to “like very much”. There is no significant difference existed in increasing the amount of glycerol in RTE dried tocino in terms of color, texture, flavor, and general acceptability. This implies that addition of glycerol from 2.5% - 7.5% does not affect the sensory properties of RTE dried tocino.

Table 6. Mean Scores for Color, Texture, Flavor, and General Acceptability of RTE Dried Tocino with Varying Amount of Propylene Glycol

Sensory Attributes	Different Concentration of Propylene Glycol			
	2.5%	5%	7.5%	0% (R)
*Color	5.80 ^a	6.20 ^a	5.20 ^a	
*Texture	4.87 ^b	5.33 ^b	4.87 ^b	
*Flavor	5.73 ^c	5.80 ^c	5.87 ^c	
**General Acceptability	6.40 ^{da}	5.53 ^{db}	4.73 ^{db}	6.80 ^{da}

* Multiple Comparison Method, **Hedonic Rating Scale
Note: Means having the different letters within the same row differ significantly at $p < 0.5$

Propylene Glycol

RTE dried tocino with 2.5% to 7.5% propylene glycol have obtained an average score of “slightly inferior to R” to “equal to R” as shown in Table 6. The sensory panel favored RTE dried tocino with 7.5% propylene glycol; this may be due to the slight change on the color, from darker to light red at higher concentration. All samples with propylene glycol were rated “equal to R” and “Slightly inferior to R” for texture and flavor respectively. General acceptability obtained an average rating of “Like slightly” to “Neither like nor dislike”. This reveals that the addition of propylene glycol affects general acceptability on which the greater the amount of propylene glycol in RTE dried tocino the unacceptable it becomes. This may be attributed to the bitter flavor imparts by propylene glycol.

Table 7. Mean Scores for Color, Texture, Flavor, and General Acceptability of RTE Dried Tocino with Varying Amount of Sorbitol

Sensory Attributes	Different Concentrations of Sorbitol			
	2.5%	5%	7.5%	0% (R)
*Color	4.27 ^a	4.47 ^a	4.00 ^a	
*Texture	5.40 ^b	5.20 ^b	5.27 ^b	
*Flavor	4.67 ^c	5.00 ^c	4.33 ^c	
**General Acceptability	7.00 ^d	6.80 ^d	7.00 ^d	6.87 ^d

*Multiple Comparison Method, **Hedonic Rating Scale
Note: Means having the different letters within the same row differ significantly at $p < 0.5$

Sorbitol

Given the results in Table 7, mean scores for color show that RTE dried tocino with 2.5%, 5%, and 7.5% sorbitol are “slightly better than R”. This implied that addition of sorbitol in RTE dried tocino improved the color of the product from pale red to dark red color. All samples with 2.5% to 7.5% sorbitol are comparable to control. Slight improvement in the flavor was observed at 7.5% concentration of sorbitol. RTE dried tocino are all rated as “Like moderately” in terms of general acceptability. This suggests that addition of sorbitol in RTE dried tocino does not affect the general acceptability of the product as perceived by the panelists.

3.2. 2. b. Sensory Evaluation for RTE dried tocino with different humectants at the acceptable level

The most acceptable level of proportion for each humectants used in RTE dried tocino were selected and subjected again to sensory evaluation. This was done to compare and to critically determine

the most acceptable humectants to use in RTE dried tocino which would eventually be subjected to different drying time. The mean scores of the sensory properties of RTE dried tocino with different humectants were presented in Table 8.

Table 8. Mean Scores for Color, Texture, Flavor, and General Acceptability of RTE Dried Tocino with Different Types and Concentration of Acceptable Humectants

Sensory Attributes	Different Types and Concentration of Acceptable Humectants			
	Glycerol (2.5%)	Propylene Glycol (2.5%)	Sorbitol (7.5%)	R (0%)
*Color	3.93 ^a	5.87 ^{ab}	5.73 ^{ab}	
*Texture	5.33 ^b	5.47 ^b	5.27 ^b	
*Flavor	3.87 ^{ca}	5.93 ^c	4.27 ^{ca}	
**General Acceptability	7.27 ^d	5.8 ^{da}	7.13 ^d	7.20 ^d

* Multiple Comparison Method, **Hedonic Rating Scale
 Note: Means having the different letters within the same row differ significantly at $p \leq 0.5$

The results revealed that the use glycerol and sorbitol in RTE dried tocino have almost similar effect in terms of sensory properties compare to propylene glycol in terms of color, flavor, and general acceptability. Comments from the members of the sensory panel were RTE dried tocino with propylene glycol has bitter after taste and the color was pale.

3.3. Phase 3 - Determination of Appropriate Drying Time for RTE Dried Tocino

The results derived from the physico-chemical analysis and sensory evaluation from Phase 2 revealed that RTE dried tocino can be dried with or without humectants. But since, the researcher had already established the drying procedure for RTE dried tocino without humectants in Phase 1, the researcher decided to choose the most acceptable humectant to be use in this phase, to determine the appropriate and the effect of different drying time in RTE dried tocino with the most acceptable humectants.

Glycerol with 2.5% level of concentration was chosen because of its lower cost and effectiveness in lowering the Aw without affecting the physico-chemical and sensory properties of the product.

3.3.1. Physico – chemical Analyses

The results of Aw analysis of RTE dried tocino with 2.5% glycerol dried for 1 hour, 1 ½ hours and 2 hours are 0.886, 0.819, 0.783 respectively, while moisture content values are 36%, 27.254%, 21.336% respectively. It showed that the longer the drying time, the lower the water activity and moisture content become as expected. RTE dried tocino dried for 1 1/2 – 2 hours conformed to the standards of ≤ 0.85 for Aw (New Zealand Food Safety Authority, 2009), and for moisture content of 15- 30% (Hyman L, 1975); while 1 hour drying of RTE dried tocino was not sufficient to meet the required Aw and moisture content.

3.3.2. Sensory Evaluation

Table 10. Mean Scores for Color, Texture, Flavor, and General Acceptability of RTE Dried Tocino with Different Drying Times at 100°C

Sensory Attributes	Different Drying Time		
	1 hour	1 ½ hours	2 hours
Color	5.87 ^a	8.13 ^{ab}	7.20 ^{ab}
Texture	7.33 ^b	7.40 ^b	6.80 ^b
Flavor	6.67 ^c	7.73 ^{ca}	7.20 ^c
General Acceptability	6.87 ^d	7.87 ^d	7.07 ^d

Note: Means having the different letters within the same row differ significantly at $p \leq 0.5$

The mean scores of the sensory properties of RTE dried tocino with different drying time at 100°C were presented in table 10.

RTE dried for 1 ½ hours is best favored by the sensory panel which is rated as “Like very much”, this may be due to the desired color of dark red. At shorter drying time, the color becomes paler while at longer drying time the color becomes darker brownish red.

RTE dried tocino dried for 1 and 1 ½ hours are the most acceptable by the panel due to tender texture. At shorter drying time, the meat is tender while at longer drying time, the meat becomes firm and difficult to chew or masticate. This signifies that texture of RTE dried tocino is slightly affected with the increase on drying time.

With the results gathered, it clearly shows that RTE dried tocino with 2.5% glycerol level of proportion dried for 1 ½ hours is the most acceptable in terms of color, texture, flavor, and general acceptability as perceived by the sensory panel.



3.3.3. Analyses for the most acceptable product.

Microbial analysis of the most acceptable product revealed that RTE dried tocino has aerobic plate count of 3 cfu/g; negative for yeast and molds, *S. aureus* and *E. coli* which all conformed to the microbiological requirement of dried meat. For nitrate analysis, there was no nitrate residues were detected in RTE dried tocino which also complied with the allowable maximum residue limit. This reveals that RTE dried tocino is microbiologically and chemically safe for consumption and would not cause deleterious effect on the health of the consumers.

4. CONCLUSIONS

The moisture content of RTE dried tocino was improved by the addition of foods was improved with the addition of different types and amount of humectants while the A_w remains on the safe level. In terms of sensory attributes, glycerol and sorbitol has no effect on RTE dried tocino while propylene glycol has effect on color, flavor, and general acceptability; it imparts pale color and bitter flavor. The A_w and moisture content is affected by drying time. As drying time increases A_w and moisture content decreases. The appropriate drying time for RTE tocino is 1 1/2 hours using the oven. The RTE dried tocino is microbiologically and chemically safe and fit for human consumption. Further study on the packaging materials for the product, conduct of storage study, cost analysis and the use of other drying methods like cabinet and vacuum drying are recommended.

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