

Does the Packaging Make the Product? Identifying Consumers' Preference for "Natural" in Packaging

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Today's consumer is interested in safe food products and foods with "natural" ingredients. The main objective of this study was to determine consumers' purchasing decisions for ground beef labeled with different packaging technologies, specifically modified atmosphere packaging using carbon monoxide in the package atmosphere and "natural" ingredients such as rosemary extract. Choice experiments with ground beef, conducted in Germany, were used to quantify consumers' valuations of the technology-related attributes of shelf life, color, and types of packaging. Consumers placed positive values on extended shelf life and light red and cherry red colors. However, informing consumers about the specific technologies used altered their preferences for the benefits of the associated technology. Our findings suggest that consumers place a positive value on the use of the technology, yet may be confused about the use of a technology that cannot be distinguished from the product itself. This response indicates that consumer trust in the product is diluted. Understanding consumer response to information and labeling is key to developing effective policies on product labeling and warnings.

Key words: carbon monoxide, food safety, modified atmosphere packaging, natural bias, rosemary extract.

Introduction

Consumers have expressed concerns about food safety, including demands for healthy and safe meat products. In this context, keeping the color attractive is of primary importance since it is one of the first attributes consumers use to evaluate overall meat quality (Grebitus, 2008). In purchasing fresh meat in a retail environment, color has a significant impact on consumers' expectations of quality, especially freshness, even if the color does not affect taste or shelf life (Sørheim, Nissen, Aune, & Nesbakken, 2001). Although the color changes have no direct health impact, the marketability of the product with color change is often reduced, as such products are no longer desirable from consumers' perspectives (Delmore, 2009).

The color of fresh meats can change quickly from bright red to brownish red. While meat color is very important, establishing and maintaining a bright red color during retail display, along with the safety of the meat, is still a challenge (Sørheim, Aune, & Nesbakken, 1997). Modified atmosphere packaging (MAP) of fresh meat is one of the packaging technologies that increases shelf life, creates stable and attractive color, and reduces microorganism growth that may lead to spoilage (Phillips, 1996). MAP refers to the replacement of air in the package with a single gas or a mixture of gases such as a high-oxygen (O_2) atmosphere of at least 60% O_2

(Sørheim et al., 2001). In addition to using high oxygen levels, carbon monoxide (CO) can be used to preserve meat color when used in low concentrations—0.3% to 0.5%—of the gas atmosphere in the package. Carbon monoxide produces a stable bright red color, and MAP with low concentrations of CO and high concentrations of carbon dioxide (CO_2) improves meat color and shelf life (e.g., Viana, Gomide, & Vanetti, 2005). Therefore, such packaging technologies would be expected to increase consumers' confidence in the food products. However, there is increasing evidence that consumers have concerns about certain new food technologies (Grebitus, Jensen, & Roosen, 2013a; Grebitus, Jensen, Roosen, & Sebranek, 2013b).

The objective of this study was to test consumers' preferences toward meat products packaged under a modified atmosphere when different technologies were used. For example, MAP can be applied using a mixture of gases, but it can also be combined with antioxidants such as rosemary extract (e.g., Sebranek, Sewalt, Robbins, & Houser, 2005) that preserve meat color and reduce flavor changes. The use of extracts from spices such as rosemary is hypothesized to be considered more "natural" from the consumer's perspective. Hence, consumers may prefer the use of herbal extracts in packaging over methods perceived as unnatural (e.g., carbon monoxide). In this case, the development and applica-

tion of new packaging technologies that are (perceivably) more natural would be worth considering.

In summation, MAP affects color stability and food safety. The use of MAP with increased levels of CO₂ and/or removal of O₂ impedes the growth of spoilage and pathogenic bacteria (Sørheim et al., 2001). The use of naturally-based extracts in package atmosphere is an alternative that reduces quality deterioration, protects color, and extends shelf life. The effects benefit consumers due to the stable and attractive color, increased shelf life, and limited need for the use of chemical preservatives. Food producers benefit from reduced distribution costs as there are fewer deliveries over longer distances, from less waste, and from fewer losses through reduced sales. Meat that loses desirable color has reduced value because it has to be sold at reduced prices or be discarded when no longer accepted by consumers (Phillips, 1996).

Several empirical studies have addressed consumer preferences for, and retail value of, major meat product attributes (e.g., Melton, Huffman, & Shogren, 1996; Melton, Huffman, Shogren, & Fox, 1996; Nayga, Wipon, & Nichols, 2005; Tonsor, Schroeder, Fox, & Biere, 2005). With respect to color, Alfnes, Guttormsen, Steine, and Kolstad (2006) studied Norwegian consumer preferences for different salmon colors. Results revealed that consumers use color as a quality indicator and are willing to pay more for salmon fillets with normal or above-normal redness, as compared to paler fillets. Additional consumer information about the technique used to achieve the preferred salmon color did not affect the willingness to pay (WTP) for pale and normal red fillets, although consumers' WTP for above-normal red fillets decreased. This suggests a weak reaction to labeling and response to information when product appearance is perceived to be "natural." Grebitus et al. (2013b) extended the experiments by Alfnes et al. (2006) to analyze US consumer response to MAP technologies by accounting for consumers' knowledge regarding the applied technologies as well as whether consumers had heard about them in the mass media.

Approval and labeling regulations of MAP and CO in MAP differ across countries, and in this context, Grebitus et al. (2013a) considered both US and German consumer response to MAP technologies and related labeling. In the United States, MAP does not have to be labeled. Also, CO in MAP was approved by the US Food and Drug Administration (FDA) in 2002 for use in food packaging (US FDA, 2002, 2004). In contrast to the United States, MAP needs to be labeled ("packaged under a protective atmosphere" [Verpackung unter

Schutzatmosphaere]) in the European Union. Furthermore, European countries banned the application of CO in MAP in spite of a report from the European Commission (EC) Health and Consumer Protection Directorate that evaluated the technology as harmless to human health (EC, 2001). Consumer organizations are also critical of the application of CO in MAP technology related to concerns regarding possible negative health effects due to stabilized color potentially masking spoilage (Consumer Federation of America, 2006; Food and Water Watch, 2008; Schmit, 2007).

In contrast to the previous studies by Grebitus et al. (2013a; 2013b), our research explicitly tested for stabilized meat color when different MAP technologies were used and took into account different levels of information regarding the technology. In particular, this study analyzed consumer preferences when selecting new meat packaging technologies that affect meat quality and safety. The study was conducted in Germany. We investigated effects of MAP including carbon monoxide (CO-MAP) and MAP including rosemary on consumers' preferences for ground beef by applying choice experiments where participants made choices among ground beef products. The results provide industry and policy decision makers with an indicator of consumer preferences for "natural" food technologies. To date, there have been no consumer economic evaluations of such technologies. This study provides an economic evaluation of consumers' preferences for MAP including different ingredients.

Methodological Background

The main objective of this research was to measure consumer preferences relative to ground beef packaging techniques. We applied choice experiments because they deliver the most appropriate tool set to isolate individual product characteristics and their specific influence on price. In choice experiments, respondents are asked to make repeated choices between different products described by different attributes and their respective levels. The respondents' utilities depend on attribute levels, and preferences can be deduced from the choices made from these sets. This procedure enables the researcher to determine the attributes that influence the choice significantly (Alfnes & Rickertsen, 2011).

Design of Choice Experiments

Following Alfnes et al. (2006), we conducted a choice experiment to collect data that provide stated preferences of German consumers for pre-packaged ground

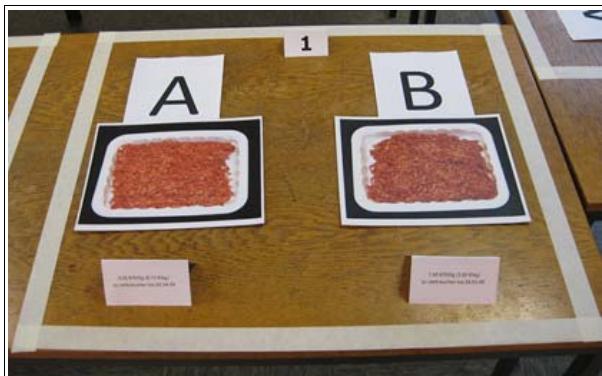


Figure 1. Example of choice set.

beef (500g). We used nine choice sets, and displayed two high-quality photographs of consumer packages of ground beef in each (see Figure 1).¹

Participants made repeated choices between scenarios of two different ground beef packages and a none-of-these option. It was explained to participants that they would have the opportunity to purchase one package of ground beef. This ground beef package was randomly drawn from all the choices made by the participant. We stressed that participants could not purchase more than one package, and would therefore not have to buy more than 500g of ground beef. We also stressed that they would have to pay money to purchase the ground beef.² In this way, the purchase was “real” and made the choices “non-hypothetical” in the sense that the participants’ choices had the potential for financial consequences.

The two alternatives of ground beef in each choice set were referred to as Alternative A and Alternative B. The experimental design included the three attributes of color, shelf life, and price with three levels each (see Table 1). The attribute levels differed from choice set to choice set according to a fractional factorial design.³

Four consecutive treatments were utilized, each containing nine choice sets. During the experiments, participants received different information (see the Appendix for the exact information provided). Before Treatment 1 (T1), participants had no information. Before Treatment

1. Since products using CO-MAP are not sold in Germany due to EU regulations, we used photographs in our experiments instead of real ground beef samples.
2. For food-safety reasons, respondents received a coupon for the ground beef they chose/purchased during the study to be redeemed at a local grocery store instead of receiving raw ground beef at the research location.
3. To generate the fractional factorial design, SAS was used.

Table 1. Attributes of the ground beef.

Attribute	Price/500g	Shelf life	Color
Level	1.95 Euro	3 days	Light red
	2.45 Euro	5 days	Cherry red
	3.05 Euro	14 days	Brownish red

2 (T2), we provided information about shelf life (i.e., the role of MAP in extending the shelf life). Before Treatment 3 (T3), we provided information about the role of CO in stabilizing the color. Before Treatment 4 (T4), we provided information about the role of rosemary extract in stabilizing the color and extending shelf life.

All information was technical, but presented in lay language and without risk or benefit information included. Furthermore, the products were labeled as shown in Table 2.

Each participant made nine choices in each of the four different treatments—36 choices in total. To summarize, in each treatment, nine choice sets were displayed, each with two photographs of packages of ground beef. The ground beef was shown with different attribute combinations of color, shelf life and price. For example, a ground beef package might have a cherry red color, a shelf life of 14 days, and cost 2.45 Euros/500g in Treatment 1. In Treatment 3, this ground beef would be labeled ‘modified atmosphere packaging with carbon monoxide’ because of the cherry red color. In Treatment 4, a cherry-red ground beef would carry either a label of ‘modified atmosphere packaging with carbon monoxide’ or ‘modified atmosphere packaging with rosemary extract.’

Sample Structure

The experiment took place in 2009 in Germany. Each participant received 20 Euros as compensation for the participation when entering the experiment. The sample consisted of 112 randomly recruited participants. The share of female and male participants was equally distributed. Participants were on average 41 years old. The average household size was between two and three persons. Eleven percent of the participants had children under the age of 12 years in their household. The education level was rather high (e.g., Master’s degrees) in the sample.

Mixed Logit Model

To analyze the data, a mixed logit model with random and independent parameters to capture taste variations was used. The mixed logit removes three limitations of

Table 2. Information provided verbally and labels used in the treatments (T).

	Information provided	Label
T1	None	None
T2	Detailed/neutral on MAP for extending shelf life	"Modified atmosphere packaging" (on packages with 14-day shelf life)
T3	Detailed/neutral on CO-MAP for stabilizing color	"Modified atmosphere packaging with carbon monoxide" (on packages with cherry-red ground beef)
T4	Detailed/neutral on Rosemary-MAP for stabilizing color	"Modified atmosphere packaging with carbon monoxide" OR "modified atmosphere packaging with rosemary extract" (on packages with cherry-red ground beef)

the standard multivariate logit model—allowing for random taste variation, unrestricted substitution patterns, and accounting for correlation over sequential choices induced by the variability in the individual-specific parameter (Train, 2003).

Underlying the mixed logit model is the consumer's random utility (U), where the utility of alternative $j=1, \dots, J$ ($J=73$), including 72 ground beef options and the "none-of-these" option, for individual $i=1, \dots, I$ ($I=112$) in choice situation $t=1, \dots, T$ ($T=36$) is described by $U_{ijt} = V_{ijt} + \varepsilon_{ijt}$, where

$$\begin{aligned} V_{ijt} = & \alpha_0 P_{jt} + \beta_1 Price_{jt} + \beta_2 5\text{-day shelf life}_{jt} + \beta_3 14\text{-day shelf life}_{jt} \\ & + \beta_4 Light\ red_{jt} + \beta_5 Cherry\ red_{jt} + \beta_6 \\ & Cherry\ red\ labeled\ as\ CO\text{-MAP}\ T3_{jt} + \beta_7 Cherry\ red\ labeled\ as\ CO\text{-MAP}\ T4_{jt} + \beta_8 Cherry\ red\ labeled\ as\ Rosemary\text{-MAP}_{jt} T4_{jt} + \beta_9 None\text{-of}\text{-these}_{jt} \\ & + \beta_{10} None\text{-of}\text{-these}\ T2_{jt} + \beta_{11} None\text{-of}\text{-these}\ T3_{jt} \\ & + \beta_{12} None\text{-of}\text{-these}\ T4_{jt}, \end{aligned} \quad (1)$$

where ε_{ijt} is the stochastic error component distributed iid extreme value over all individuals, alternatives, and choice situations; $Price_{jt}$ is the price of alternative j in choice situation t ; $5\text{-day shelf life}_{jt}$ and $14\text{-day shelf life}_{jt}$ are dummy variables equal to one if the product has a 5- and 14-day shelf life, respectively; $Light\ red_{jt}$ and $Cherry\ red_{jt}$ are dummy variables equal to one if the product is light or cherry red, respectively; $Cherry\ red\ labeled\ as\ CO\text{-MAP}_{jt} T3_{jt} / T4_{jt}$ and $Cherry\ red\ labeled\ as\ Rosemary\text{-MAP}_{jt} T4_{jt}$ are dummy variables equal to one if the product is cherry red in Treatments 3 and 4, respectively; $None\text{-of}\text{-these}_{jt}$ variables denote dummy variables equal to one if the participant chose to opt out; $None\text{-of}\text{-these}\ T2/T3/T4_{jt}$ denotes whether the individual chose to opt out in the respective treatments T2 through T4.

For identification purposes, the dummy variables for the product with a 3-day shelf life and brownish-red color were excluded from the analysis, which means, for

example, that the coefficient on 5-day shelf life shows the marginal utility for the 5-day shelf life over a product with a 3-day shelf life. The mixed logit estimates presented in this article were obtained via simulated maximum likelihood using 250 Halton draws. To estimate the model we used NLOGIT5. We used the panel version of the mixed logit because each participant gives rise to a panel of 36 choices.

Results

The results of the estimated mixed logit model are shown in Tables 3 and 4. Table 3 presents the estimated coefficients for the mean and the standard deviation, the standard errors (SE), and the z-values. Table 4 presents the marginal WTP in Euro/500g. The WTP is calculated by dividing the coefficient of the variable by the negative of the price coefficient. With regard to the estimation results, the parameter for price is significant and negative as expected. A higher price resulted in a less-preferred product. With regard to shelf life, as shown in Table 3, neither a 5-day shelf life nor a 14-day shelf life was preferred over a 3-day shelf life. However, if the shelf life was increased to 14 days, there were some consumers who preferred ground beef with an extended shelf life, as shown by the significant standard deviation coefficient.

With regard to color, the light red color of ground beef was preferred over the brownish red as expected. Also, there is some heterogeneity in the consumer responses as again shown by significant standard deviation parameters. The cherry red color was also preferred by consumers, and again the standard deviation was significant.

After providing the information that carbon monoxide was the reason for a cherry red color (Treatment 3) significance drops from the 1% level to the 5% level, but participants still showed significant preferences for a cherry red color.

After receiving information regarding rosemary extract as the reason for a cherry red color in Treatment 4, they were significantly less likely than before to

Table 3. Empirical results.

	Coeff.	SE	z-value
Mean coefficients			
Price (fixed coefficient)	-0.511	0.054 ***	-9.440
3-day shelf life			
5-day shelf life	-0.058	0.058	-1.000
14-day shelf life	-0.124	0.082	-1.520
Brownish red			
Light red	0.760	0.086 ***	8.810
Cherry red	1.416	0.121 ***	11.750
Cherry red labeled as CO-MAP T3	0.334	0.157 **	2.130
Cherry red labeled as CO-MAP T4	-0.656	0.175 ***	-3.750
Cherry red labeled as Rosemary-MAP T4	-0.711	0.199 ***	-3.570
None of these	-1.802	0.234 ***	-7.690
None of these T2	0.238	0.164	1.460
None of these T3	0.597	0.174 ***	3.430
None of these T4	0.368	0.179 **	2.050
Standard deviation coefficients			
5-day shelf life	0.064	0.075	0.850
14-day shelf life	0.689	0.078 ***	8.800
Light red	0.739	0.085 ***	8.740
Cherry red	1.438	0.108 ***	13.310
Cherry red labeled as CO-MAP T3	0.993	0.198 ***	5.020
Cherry red labeled as CO-MAP T4	0.907	0.235 ***	3.860
Cherry red labeled as Rosemary-MAP T4	1.327	0.240 ***	5.530
None of these	4.174	0.301 ***	13.850
None of these T2	0.119	0.291	0.410
None of these T3	0.060	0.155	0.390
None of these T4	0.375	0.222 *	1.690
Chi²	2,687.91		
Restr. LL	-4,429.61		
McFadden Pseudo R²	0.303		
Obs	4,032		

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

choose the cherry red that was labeled as either CO-MAP or Rosemary-MAP. Both coefficients are significantly negative. These results suggest that some consumers do not trust either technology. However, because rosemary was introduced after another type of technology change (the CO-MAP), the combination of the two technologies could have led to a negative coefficient for both rosemary and CO-MAP, even though by itself rosemary might be preferred. While there was no discount on color after information on CO-MAP, there is a discount on color after information about rosemary. Perhaps people do not trust rosemary as an effective technology to protect color. Also, there was heterogeneity in responses among the consumers for cherry red color labeled as CO-MAP in both T3 and T4, and for cherry red color labeled as Rosemary-MAP. This means that there are consumers who have a significant preference for or against the labeling, a result that suggests there is a market segment that industry and retailers can focus on in promoting such products. The results for the “none-of-these options” support this. The coefficient is significantly negative in general—meaning that individuals would rather choose to buy something than nothing. Once participants received more information and saw the labels for color they chose to opt out of purchasing the respective ground beef samples in both T3 and T4.

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Table 4. Marginal willingness to pay.

	WTP (Euro/500g)
5-day shelf life	-0.11
14-day shelf life	-0.24
Light red	1.49
Cherry red	2.77
Cherry red labeled as CO-MAP T3	3.42
Cherry red labeled as CO-MAP T4	2.14
Cherry red labeled as Rosemary-MAP	2.03

WTP=marginal willingness to pay

However, there is some heterogeneity among consumers, as shown by significant standard deviation coefficients.

The results on the marginal WTP presented in Table 4 show that the WTP for extended shelf life is negative in this model; however, the coefficients were not significant. Ground beef with a light red color derived from air alone was preferred by consumers (as compared to a brownish-red ground beef), and the WTP increased by 1.49 Euro/500g. The cherry red color increased consumers' WTP to 2.77 Euro/500g, and this premium even increased to 3.42 Euro/500g once consumers were informed about the underlying production methods. However, too much information diminished the WTP. After learning that the cherry red color can be produced using either carbon monoxide or rosemary extract in Treatment 4, the WTP for both CO-MAP and Rosemary-MAP became smaller, though still positive, and decreased to 2.14 Euro/500g and 2.03 Euro/500g for the cherry red color labeled CO-MAP and Rosemary-MAP, respectively. Despite the decrease, as the results show, WTP was still positive, which means that stabilizing the color holds value to consumers with or without informing consumers about the production methods used.

Conclusion

This study evaluated consumers' purchase decisions about ground beef packaged under a modified atmosphere with and without carbon monoxide and rosemary extract in Germany. Thus far, no studies have analyzed consumers' responses and economic valuations of these technologies combined. Consequently, we applied choice experiments to assess consumers' preferences for ground beef attributes related to these technologies. In particular, we examined response to color stabilized by CO-MAP and Rosemary-MAP. The choice experiments contained four treatments that provided consumers with alternative types of information about the technologies. Overall, results showed that some consumers prefer

ground beef with an extended shelf life. Light red color was slightly preferred, and cherry red color was strongly preferred in ground beef over the brownish-red color, a preference that has been well-documented relative to consumer response to meat color differences.

Though the MAP technology increases shelf life and stabilizes meat color, our results showed that informing consumers about the different techniques used ultimately decreased their preferences for the benefits of the associated technology. The results suggest that consumers are not in favor of the more natural technique of extending ground beef color by including rosemary extract. We expected to find a positive effect of rosemary compared to carbon monoxide; instead the effect was smaller in terms of WTP. The fact that this technology was only introduced in Treatment 4 might have led to a bias in the results. This result suggests the need for future research focusing solely on the effects of rosemary extract included in MAP products. Further research could also analyze the taste expectations that consumers may associate with spices for product preservation.

Policies concerning the provision of information on MAP to consumers differ by country (Grebitus et al., 2013a). In Germany in particular and the EU in general, MAP needs to be labeled; in the United States, MAP does not have to be labeled. Our results show that consumers would perceive labeling information generally in a positive light and would consider the additional information to be helpful. However, the findings also suggest that consumers may be confused about the use of a technology that cannot be distinguished from the product itself and this may dilute consumer trust in the product. For markets such as the United States, voluntary labeling could be an option and does have advantages for the industry, but some food-safety concerns need consideration. Depending on the MAP used (high- or low-oxygen MAP), pathogens will grow faster if chilled temperatures are not maintained. Furthermore, the cherry red color, if extended beyond the typical product shelf life, could mask possible spoilage after the use-by date. Therefore, if consumers do not pay attention to the use-by date, they may face increased food-safety risks. In this case, labeling programs may not be sufficient to protect consumers from the potential food-safety risks, and additional consumer education may be required. A label communicating that a product uses MAP and therefore may require additional caution on the need for appropriate temperature control and attention to shelf life would help to provide the necessary food-safety guidance for consumers.

Regarding CO-MAP and Rosemary-MAP technologies in particular, consumers' preferences for these technologies in fresh meat products have important implications for public health policy and marketing as well as research and product development. As mentioned above, CO-MAP is not allowed in the European Union but can be applied in the United States. The EU banned CO-MAP applications despite the report by the EC Directorate that stated no harm of CO-MAP to consumers. In this regard, two implications arise from our research. First, restriction on the use of CO-MAP in the EU/Germany is not consistent with the positive findings of our study for the technology and the clear preference for the cherry red color of ground beef packaged under CO-MAP. Our findings suggest that consumers place positive value on the use of the technology. Hence, this raises the question of whether the use of CO-MAP in the EU should be reconsidered in light of consumers' preferences. Second, although the application of "natural" MAP technologies could lead to a positive WTP, the effect found was similar to that of CO-MAP—at least in our study design. In our results, the Rosemary-MAP had no particular advantage. Hence, companies could choose the more cost-effective packaging technology for their product. Finally, it is important to note that in conducting the experiments, the consistent order of the treatments for all respondents may present a limitation in the experimental design for eliciting information about the rosemary attribute. Thus, there is the possibility that the order of the treatments may have affected the impact of labeling the different types of MAP, and the impact of providing information regarding the packaging technology.

Ultimately, understanding consumer response to technology-related information and labeling is key to developing effective policies on product labeling and warnings. It requires a solid understanding of consumers' concern for food safety and appreciation of technology.

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Appendix

Information Provided During the Experiments

Information Provided Before Treatment 2

Some technologies such as modified atmosphere packaging (MAP) will extend food products' shelf life. MAP relies on altering the composition of gases in contact with the food by replacing pure air with a single gas or a mixture of gases such as carbon dioxide. This is then combined with low-temperature storage of less than 2.8 degrees Celsius. Beyond that, the aim of MAP is to exclude or greatly reduce oxygen levels, to retain the moisture content of the food, and to inhibit aerobic microbial growth.

Information Provided Before Treatment 3

Red-meat products are somewhat like sliced apples. Their color can change rapidly—even though the product is still safe and wholesome. In fact, retail stores often discount red meat products that have changed color but are still safe and wholesome—and well within their shelf life. When products become unmarketable purely on the grounds of cosmetic reasons during their regular shelf life, this can add costs to the supply system, which in turn can raise meat prices. Modified atmosphere packaging can stabilize the color of ground beef—in addition to extending the shelf life. Modified atmosphere packaging includes different mixtures of gases, for example, with high or low oxygen levels. By eliminating the oxygen from the package and adding minute amounts of the carbon monoxide gas along with other protective gases to the headspace of the red meat packages, products like ground beef can maintain their appealing red color throughout their shelf life. Thus, they do not lose their marketability. Carbon monoxide systems for meat have been available for about four years. To summarize, carbon monoxide is a color stabilizer that maintains the typical red color of fresh meat when the gas mixture is applied to the package.

Information Provided Before Treatment 4

Beyond packaging techniques that use different gases to extend the shelf life or stabilize the color of ground beef, there are other techniques that use ingredients such as rosemary and oregano extract for shelf life extension and color stabilization. These packaging techniques may also be used to enhance shelf life and color.