

## PORK QUALITY

**Title:** Interaction of Non-Meat Ingredients in Enhanced Pork Loin Chops  
**NPB# 01-101**

**Investigator:** Rhonda Miller

**Institution:** Texas A&M University

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- I. Abstract:** Fresh, vacuum-packaged pork loins were obtained from a commercial pork processor and used in a five-part study to examine the effects of salt, sodium phosphates, sodium lactate, potassium lactate and sodium diacetate on the chemical, color, sensory and package level levels of pork chops stored 0, 7, 14, 21 and 28 days. The first experiment examined the effects of salt (0, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00%) and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) in the final product. The second experiment as designed as experiment 1 except a more soluble sodium phosphate was used to understand how sodium phosphate type affects these attributes. In the third experiment, salt was standardized at .75% and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) and sodium lactate (0, 1, 2, 3 and 4%) differed. In the fourth experiment, salt was again standardized at .75% and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) and potassium lactate (0, 1, 2, 3 and 4%) were added. In the fifth experiment, salt and potassium lactate were standardized at .75% and 2%, respectively and sodium phosphate was evaluated at 0, 0.1, 0.2, 0.3 and 0.4% and sodium diacetate were used at 0, 0.05, 0.10, 0.15 and 0.20%. Results from the Experiment 1 showed that salt levels should not exceed 1% and sodium phosphate levels should not exceed .2% in enhance pork loin chops to maximize sensory flavor and texture attributes while being able to maintain high water holding capacity. Experiment 2 used a more rapid acting, soluble phosphate that is more commonly used in enhanced pork products. Results from Experiment 2 indicated that the interaction of salt and sodium phosphates were similar in Experiment 1 and 2; however, processed meat-like bite was greater due to the addition of the different sodium phosphate in Experiment 2. Experiment 3 examined the interaction of sodium lactate and sodium phosphates on meat chemical and sensory characteristics. Sodium lactate addition tended to not impact water holding capacity measurements and cooked pork lean/brothy, but increased salt basic tastes. The combination of sodium phosphates and sodium lactate did not appear to have alter the functionality or enhance the functionality of the individual ingredients; in other words, the ingredients acted as previously reported in the literature and there were no synergistic effects when they were used in combination. Experiment 4 examined

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**For more information contact:**

**National Pork Board, P.O. Box 9114, Des Moines, Iowa USA**

800-456-7675, Fax: 515-223-2646, E-Mail: [porkboard@porkboard.org](mailto:porkboard@porkboard.org), Web: <http://www.porkboard.org/>

the effect of potassium lactate and sodium phosphates on pork loin chop chemical, sensory and color characteristics. Results from Experiment 4 showed that the addition of sodium or potassium lactate had minimal effects on sensory characteristics of pork loin chops. It was interesting that potassium lactate had a greater effect on increasing the level of processed meat-like bite than sodium lactate. Experiment 5 looked at the addition of sodium diacetate in combination with sodium phosphates. Sodium diacetate is used as an antimicrobial agent in enhanced pork chops. While sodium diacetate is the salt form of acetic acid, the pH of the ingredient is lower than either sodium or potassium lactates. This lower pH could decrease water holding capacity, increase package purge, lighten color and result in off-flavors such as sour in enhanced pork loin chops. In experiment 5, the addition of up to 0.1% sodium diacetate did not affect the sensory and color characteristics of enhanced pork loin chops. Using this information in combination with the color, purge and other sensory information will allow product development personnel to make more informed decisions on what levels of salt and sodium phosphates to use in their enhanced pork products.

## **II. Introduction:**

Enhanced pork is the process of adding non-meat ingredients to fresh pork to improve the eating quality, defined as juiciness, tenderness and flavor, and to extend the microbial and color shelf-life of pork. Enhancement of pork loin chops, roasts, and ribs are a common industry practice and the predominant fresh pork products available at the retail meat case and in the food service industry are enhanced. For retail pork cuts, pork products contain on average 7 to 12% of an injection solution with solutions most often containing water, sodium lactate (NaL), sodium phosphates (NaP), potassium lactate (KL), and/or sodium diacetate (NaD). As researchers, we know a lot about the functionality of these ingredients. A summary of the impact of these ingredients on palatability, flavor shelf-life, microbial shelf-life and microbial safety is presented in Table 1. While it is obvious that these ingredients are extensively used and that their functionalities are known, there is limited information regarding textural changes that occur during the storage of vacuumed-packaged fresh pork loins injected with varying combinations of these non-meat ingredients. Complaints of texture issues include that the enhanced pork is too soft, or that the texture is more like-ham than meat-like. Some research has found that the addition of organic salts, NaL and/or NaP, to beef roasts caused the texture to become more dense when compared to a control (Weber, 2000). Weber (2000) also found that with the addition of organic salts, springiness, cohesiveness, and hardness of beef roasts increased over time. Anwar et al. (2000) found that the texture of beef steaks injected with KL and/or NaD changed from a steak-like bite to a soft/rubbery, processed meat texture during refrigerated storage over a 42 day period. Maca et al. (1997) found that springiness and hardness increased with NaL and/or NaP addition in cooked beef top rounds. While these studies were not conducted using enhanced pork, they indicate that texture changes occur during storage in meat products where non-meat ingredients are used. These texture changes have not been examined in enhanced pork chops and the effect of combination of ingredients on texture changes has not been evaluated. These changes in texture affect the consistency of the final product. As enhanced products have a longer shelf-life, consumers may purchase products at varying times during the life of the product. Changes in

texture during shelf-life may induce variation on these products and result in a more inconsistent product. By understanding the combined effect of water, salt, sodium lactate, sodium phosphate, sodium diacetate, and potassium lactate on palatability, texture, color, pH, and water-holding capacity of pork loin chops during vacuum-packaged, refrigerated storage, the pork industry can provide a more consistent enhanced product to consumers.

Therefore, a study is being conducted in my laboratory that was been funded by the National Pork Board using check-off dollars to understand the interaction of water, salt, sodium lactate, sodium phosphates, sodium diacetate, and potassium lactate on pork loin chop palatability. We also are evaluating the pH, color, water-holding capacity and shelf-life stability of injected vacuumed-packaged pork loin chops during storage to provide added information on the effects of combination of these ingredients during storage. These data then can provide industry personnel an understanding of how changing ingredients impacts their final product during storage.

### **III. Objectives:**

The overall objective of this research project is to examine the use of non-meat ingredients to improve the color, eating quality and shelf-life of enhanced pork cuts. Our research efforts will examine the use of water, salt, sodium lactate, potassium lactate, and/or sodium diacetate combinations in pork cuts. The sub-objectives are:

1. To establish the relationship between the addition of water, salt, sodium lactate, potassium lactate, and/or sodium diacetate combinations and pork muscle pH, color, and water holding capacity;
2. To examine the effect of addition of these ingredients on meat eating quality, especially meat texture characteristics; and
3. To determine the effect of addition of these ingredients on shelf-life in the retail meat case under standardized vacuum-packaging conditions.

### **IV. Procedures:**

Fresh, vacuum-packaged pork loins were obtained from a commercial pork processor for injection. The study was conducted in five segments where two ingredient combinations were studied in each segment. In the first segment or study, the effects of salt (0, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00%) and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) in the final product were examined. In the second segment, salt level and sodium phosphate were used as defined in the first segment, but a different sodium phosphate was used to understand how sodium phosphate type affects these attributes. In the third segment or study, salt was standardized at .75% and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) and sodium lactate (0, 1, 2, 3 and 4%) differed. In the fourth study, salt was again standardized at .75% and sodium phosphate (0, 0.1, 0.2, 0.3 and 0.4%) and potassium lactate (0, 1, 2, 3 and 4%) were added. In the fifth segment or study, salt and potassium lactate were standardized at .75% and 2%, respectively and sodium phosphate was evaluated at 0, 0.1, 0.2, 0.3 and 0.4% and sodium diacetate were used at 0, 0.05, 0.10, 0.15 and 0.20%.

The standardized injection level was 10% of the fresh weight of the pre-injected loin. Injected pork loins were held 24 h, segmented into 2.54 cm thick pork loin chops, vacuumed packaged in oxygen barrier film (Cryovac Division, WR

Grace & CO., Duncan, SC., U.S.A.) and stored at 4 °C. The pork loin chops with a loin were randomly assigned to storage days (0, 7, 14, 21, 28) within a treatment for trained descriptive attribute sensory evaluation. Package purge, color space values of L\*, a\*, and b\* (measured with a Minolta colorimeter), pH, and water-holding capacity (using drip loss method) were determined on 2.54 cm pork loin chops prior to cooking for each treatment on each storage day.

To determine package purge, the vacuumed-packaged pork loin chop was weighed prior to opening. The vacuum-package was opened, the pork loin chop removed from the package, and weighed. The vacuum-package of the pork loin chop was weighed without the free juices. Purge weight percentage was determined using the following formula:

$$\text{Package purge weight, \%} = \left[ 100 - \frac{(\text{Pork loin chop weight})}{(\text{Unopened package weight} - \text{Dry package weight})} \right] \times 100$$

For color evaluation, the Minolta colorimeter was used to determine the L\*, a\*, and b\* color space values on 3 random locations of the raw pork loin chop lean surface 10 min after removal from the vacuum package (AMSA, 1993). Subjective color was determined by a trained descriptive attribute sensory panel using the 6-point color scale from the National Pork Producers Council.

pH evaluation was performed in duplicate on the fresh pork loin, brine, and injected pork loin product using a hand-held probe. Water-holding capacity was determined by the drip loss procedure using a modified method of Kauffman (1986). Approximately 20 g muscle sample was weighed, suspended in ham netting within a Whirl-pak® bag and held at 4 °C for 48 h. Samples then were re-weighed and percentage drip loss determined.

For sensory evaluation ballot development sessions during preliminary studies were used to determine the flavor, aromatics, basic tastes, aftertastes, mouthfeels, and texture attributes. Up to 10 sensory panelists were selected and trained according to Cross et al. (1978) and AMSA (1995). Pork loin chops were cooked on a Farberware Open-Hearth Electric Broiler to an internal temperature of 70 °C. Internal temperature was monitored using type T wire mini-thermocouples placed in the geometric center of each pork loin chop and temperature was monitored by an Omega RD4031 Hybrid Recorder (Omega Engineering Inc., Samford, CT., U.S.A.). Cook yield percentage was determined by the following formula:

$$\text{Cook yield, \%} = \left[ \frac{(\text{Raw pork loin chop weight} - \text{cooked pork loin chop weight})}{(\text{Raw pork loin chop weight})} \right] \times 100$$

Cooking time also was recorded. Pork loin chops were held in the Alto Shaam (750-TH-11, Alto-Shaam, Inc. Milwaukee, WI., U.S.A.) set at 55 °C prior to serving and for no longer than 10 min. Serving preparation included removing .64 cm of the exterior edge of the pork loin chops and cutting the remainder into 1 cm cubes. To minimize positional bias and halo effects, the order of sample presentation was randomized within each sensory session (Larmond 1977). Testing took place in climate controlled, partitioned booths separated from the sample preparation area so that panelists were not be disturbed during evaluation. Two cubes were placed in approved odor-free plastic weigh boats and served to panelist through bread-box style stainless steel domes that separate the food preparation area from the sensory testing area. The separation was necessary to prevent odors and noise in the evaluation booths. Cool incandescent lights with red filters were used to disguise visual differences among the samples. To prevent

taste fatigue, expectorant cups were provided and panelist were instructed not to swallow the samples. Distilled, deionized water, unsalted soda crackers, and whole ricotta cheese were used to clean the palate between samples.

The data were analyzed using central composite response surface regression designed to examine two subsequent variables of either salt, sodium phosphate, sodium lactate, potassium lactate, or sodium diacetate. Least squares main effects for treatments also were analyzed using Proc GLM of SAS (1991) and when treatment was significant ( $P < 0.05$ ), then least squares means were separated using the standard error pdiff procedure ( $P < 0.05$ ) of SAS (1991).

## V. Results:

*Experiment 1.* Experiment 1 was used to examine the effects of sodium chloride levels or salt at 0 to 2% in the final product and sodium phosphates from 0 to .4% in the final product. These levels were selected to represent the range of levels that may be used in enhanced fresh pork products. The sodium phosphate used in this experiment was a slow release phosphate that is commercially available, but is often times used in beef and not pork products. Multiple variables were measured and the response of significant ( $P < 0.05$ ) presented in Etheridge (2003); however, only the major variables impacting pork quality will be presented in this report. Package purge is a measurement of the ability of enhanced pork loin chops to maintain or absorb brines and normal meat juices. We measured package purge (%) from 0 to 28 days of vacuum-packaged refrigerated storage at 4°C (Figure 1). Obviously, package purge was not affected by salt or sodium phosphate levels on day 0; however, as storage days increased, package purge was more evident in the packages. As would be expected, as salt and sodium phosphate levels increased, the amount of package purge decreased. Interestingly, pork chops containing the 2% salt and 0% sodium phosphates had the lowest percentage of package purge. The chemical measurement of water holding capacity (Figure 2) show similar results. While it has been well documented that the addition of salt and sodium phosphates increase the ability of meat proteins to hold water and there is a subsequent reduction in package purge, combining this information with optimal sensory and color attributes is important.

Pork loin chops were evaluated by a trained, meat descriptive attribute sensory panel for numerous sensory flavor, basic tastes, mouth-feels, aftertastes and tenderness/texture measurements. Each attribute was evaluated; however, only the major sensory attributes of cooked pork lean/brothy, salt basic taste and processed meat-like bite will be presented as these attributes are of utmost interest. The remainder of the attributes are presented in Etheridge (2003). Salt has been shown to enhance pork lean/brothy flavor. It is hypothesized that when salt flavor is too high, pork lean/brothy flavors may be masked by the more intense salt flavor. As salt level increased from 0 to about 1% in the final product, cooked pork lean/brothy increased, but as salt levels increased above 1%, cooked pork lean/brothy changed minimally or decreased slightly. This effect was especially apparent in pork loin chops stored from 14 to 28 days. Additionally, as sodium phosphate levels had very little effect on cooked pork lean/brothy. While pork lean/brothy is a positive flavor attributes, other flavor attributes also may have been enhanced by the addition of these ingredients.

Processed meat-like bite or the texture of the pork chop that changed from very chop or steak like at 0 to more ham-like (softer and rubbery) with increasing levels was affected by salt and sodium levels (Figure 4). As storage time

increased, the level of processed meat-like bite increased. This would be expected as with time, salt soluble meat proteins would have more opportunity to bind water and to form a matrix. Increasing sodium phosphate levels impacted increasing processed meat-like bite more than increasing salt levels. Interestingly, increasing salt levels up to about 1% increased processed meat-like bite and with additional salt levels, processed meat-like bite decreased for pork loin chops stored 7 and 14 days. However, increasing sodium phosphate levels sequentially increased processed meat-like bite. Sodium phosphate levels of .2 and higher generally increased processed meat-like bite.

Color is an important attribute for pork as consumers use color as a determinant for purchase and quality assessment. Increasing levels of salt decreased the color of enhanced pork chops for each storage day (Figure 6). Color only slightly decreased or increased with the addition of up to 1% salt. The addition of sodium phosphates increased color. These results have been previously reported and have been attributed to sodium phosphates effect on increasing lean pH and as sodium phosphates increase water holding capacity, less free water is available for light reflection and the resultant pork chops is darker. Figure 6 shows that the addition of up to 1% salt and up to 0.2% sodium phosphates had the most positive (darker) effect on pork loin chop color.

Based on these results, it would be recommended that salt levels not exceed 1% and sodium phosphate levels not exceed .2% in enhance pork loin chops.

*Experiment 2.* Experiment 2 used a more rapid acting, soluble phosphate that is more commonly used in enhanced pork products. The package purge was higher in pork chops after 7 days of storage in Experiment 2 than in Experiment 1 (Figure 7). Additionally, increased salt levels tended to more dramatically decrease package purge levels during storage in Experiment 1. Increasing sodium phosphate levels tended to decrease package as similarly presented in Experiment 1.

Cooked pork lean/brothy and salt basic tastes increased slightly as salt levels increased and this sensory attribute was not affected by sodium phosphate addition as reported in Experiment 1 (Figures 8 and 9, respectively). However, processed meat-like bite was higher in pork chops in Experiment 2 (Figure 10). As salt levels increased, processed meat-like bite increased and the addition of sodium phosphates tended to decrease the processed meat-like bite when salt was added at about 1% or greater in pork chops stored from 0 to 28 days. When pork chops contained less than 1% salt, increasing levels of sodium phosphates resulted in pork chops with greater amounts of processed meat-like bite. As salt level increased, color was darker in pork chops from Experiment 2 and the combined addition of higher levels of salt and sodium phosphates increased pork chop lean color (Figure 11). However, this effect was more pronounced in pork chops containing greater than about 1% salt and greater than 0.2% sodium phosphates.

These results indicate that the interaction of salt and sodium phosphates were similar in Experiment 1 and 2; however, processed meat-like bite was greater due to the addition of the different sodium phosphate.

*Experiment 3.* Experiment 3 examined the interaction of sodium lactate and sodium phosphates on meat chemical and sensory characteristics (Figures 12 to 17). Sodium lactate addition had little effect on package purge; however, package purge tended to decrease, except on storage day 21, as sodium phosphate levels increased. Water holding capacity was not affected by sodium lactate level. As

sodium phosphate levels increased, water holding capacity changed slightly, but not consistently across levels or storage. Pork lean/brothy increased slightly with increasing sodium lactate levels and sodium phosphate levels, but changes were minimal and this flavor change would not impact overall flavor. As sodium lactate and sodium phosphate levels increased, salt basic taste increased. As both ingredients contain a sodium ion, it would be expected that salt basic taste would increase with increasing levels. The addition of sodium lactate increased processed meat-like bite and the addition of up to 2% tended to increase this effect; however, subsequent addition over 2% did not increase processed meat-like bite. The addition of sodium lactate increased pork loin chop color slightly as level of sodium lactate increased.

In summary, sodium lactate addition tended to not impact water holding capacity measurements and cooked pork lean/brothy, but increased salt basic tastes. The combination of sodium phosphates and sodium lactate did not appear to have alter the functionality or enhance the functionality of the individual ingredients; in other words, the ingredients acted as previously reported in the literature and there were no synergistic effects when they were used in combination.

*Experiment 4.* Experiment 4 examined the effect of potassium lactate and sodium phosphates on pork loin chop chemical, sensory and color characteristics (Figures 18 to 21). The reason for examining sodium lactate in Experiment 3 and potassium lactate in Experiment 4 were that many processors use one of these ingredients as antimicrobial agents to extend the shelf-life of vacuum-packaged pork loin chops. While sodium lactate was the original ingredients used as an antimicrobial, there are off-flavors associated with its use. Therefore, potassium lactate that does not have the off-flavors of sodium lactate, have been used in place of sodium lactate. There is limited information that compares the functionality of these two ingredients. Therefore, we were interested in if potassium lactate and sodium lactate have the same functionality in this system.

Potassium lactate and sodium lactate responded similarly in slightly reducing package purge and therefore had similar effects as sodium lactate in improving water holding capacity. From a flavor standpoint, potassium lactate and sodium lactate had similar flavor and basic tastes when added to enhanced pork loin chops.

The greatest effect of the addition of potassium lactate to enhanced pork loin chops was that potassium lactate addition impacted processed meat-like bite to a greater extent than the addition of sodium lactate. It was interesting that the addition of potassium lactate at greater than 2% in combination with sodium phosphates also enhanced processed meat-like bite. This effect was expected. This indicates that the addition of potassium lactate has a negative effect on processed meat-like bite; but the addition of potassium lactate at 2% or greater in combination with sodium phosphates also increases this negative effect. It would be recommended to limit sodium phosphate addition of less than 0.2% to minimize this negative texture attribute.

Pork chop color was darker as level of potassium lactate increased at day 0, but this effect was not as apparent with increased storage. Sodium and potassium lactate had similar effects on pork loin chop color.

These results indicate that the addition of sodium or potassium lactate had minimal effects on sensory characteristics of pork loin chops. It was interesting

that potassium lactate had a greater effect on increasing the level of processed meat-like bite than sodium lactate.

*Experiment 5.* Sodium diacetate is used as an antimicrobial agent in enhanced pork chops. While sodium diacetate is the salt form of acetic acid, the pH of the ingredient is lower than either sodium or potassium lactate. This lower pH could decrease water holding capacity, increase package purge, lighten color and result in off-flavors such as sour in enhanced pork loin chops. The addition of sodium diacetate did not affect cooked pork lean/brothy (Figure 22), but as the level of sodium diacetate increased, salt basic taste increased slightly and this higher salt level was detected during storage (Figure 23). Additionally, processed meat-like bite increased with subsequent increases in the level of sodium diacetate addition to pork loin chops and this effect was apparent throughout storage. However, the addition of about 0.1% sodium diacetate would provide a mid-range to minimize this effect (Figure 24). Interestingly, the addition of sodium diacetate did not impact pork loin color (Figure 25).

Based on these results, the addition of up to 0.1% sodium diacetate did not affect the sensory and color characteristics of enhanced pork loin chops.



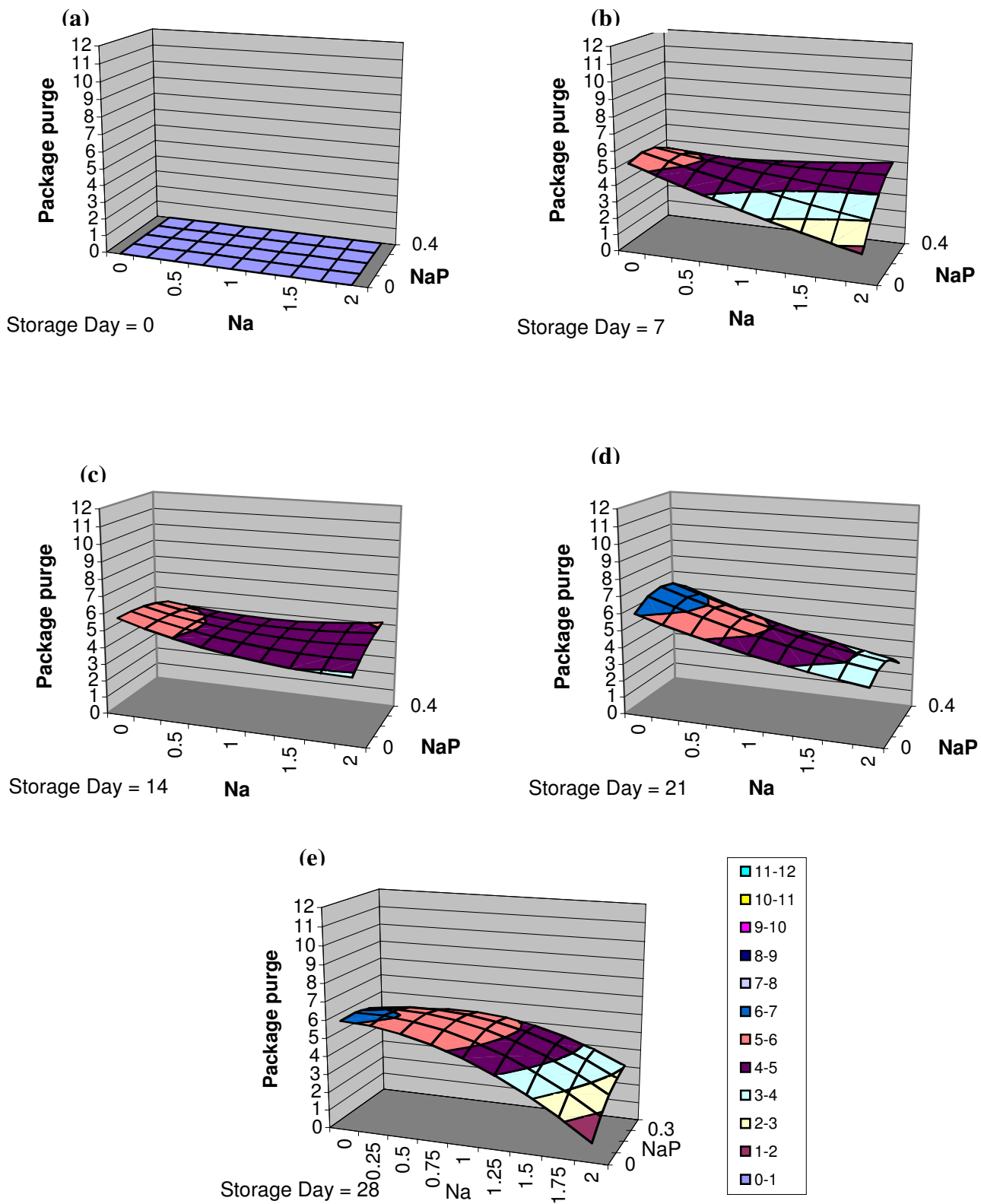


Figure 1. Effect of sodium phosphate (NaP) and salt (Na) levels on package purge of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 1.

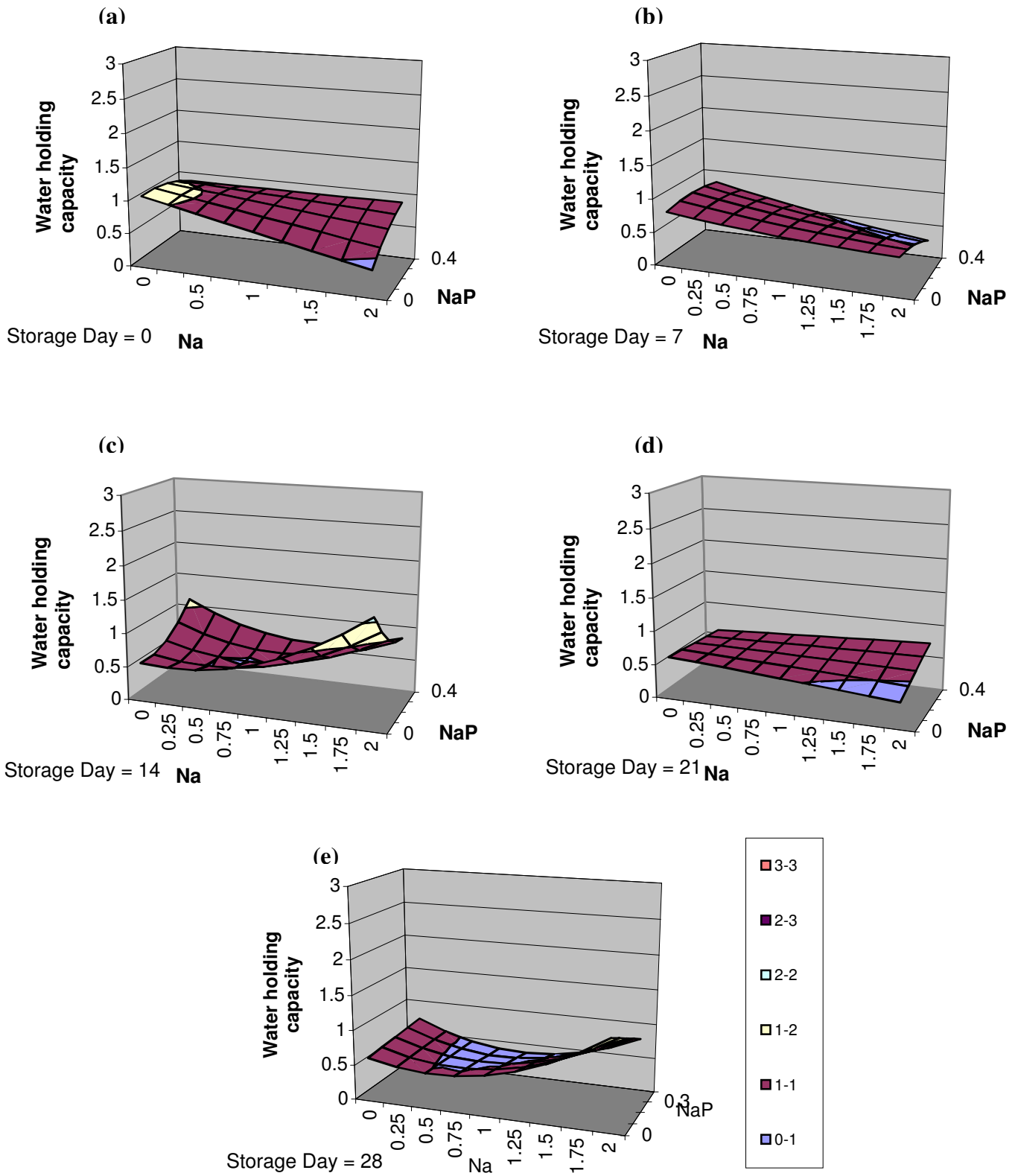


Figure 2. Effect of sodium phosphate (NaP) and salt (Na) levels on water holding capacity of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 1.

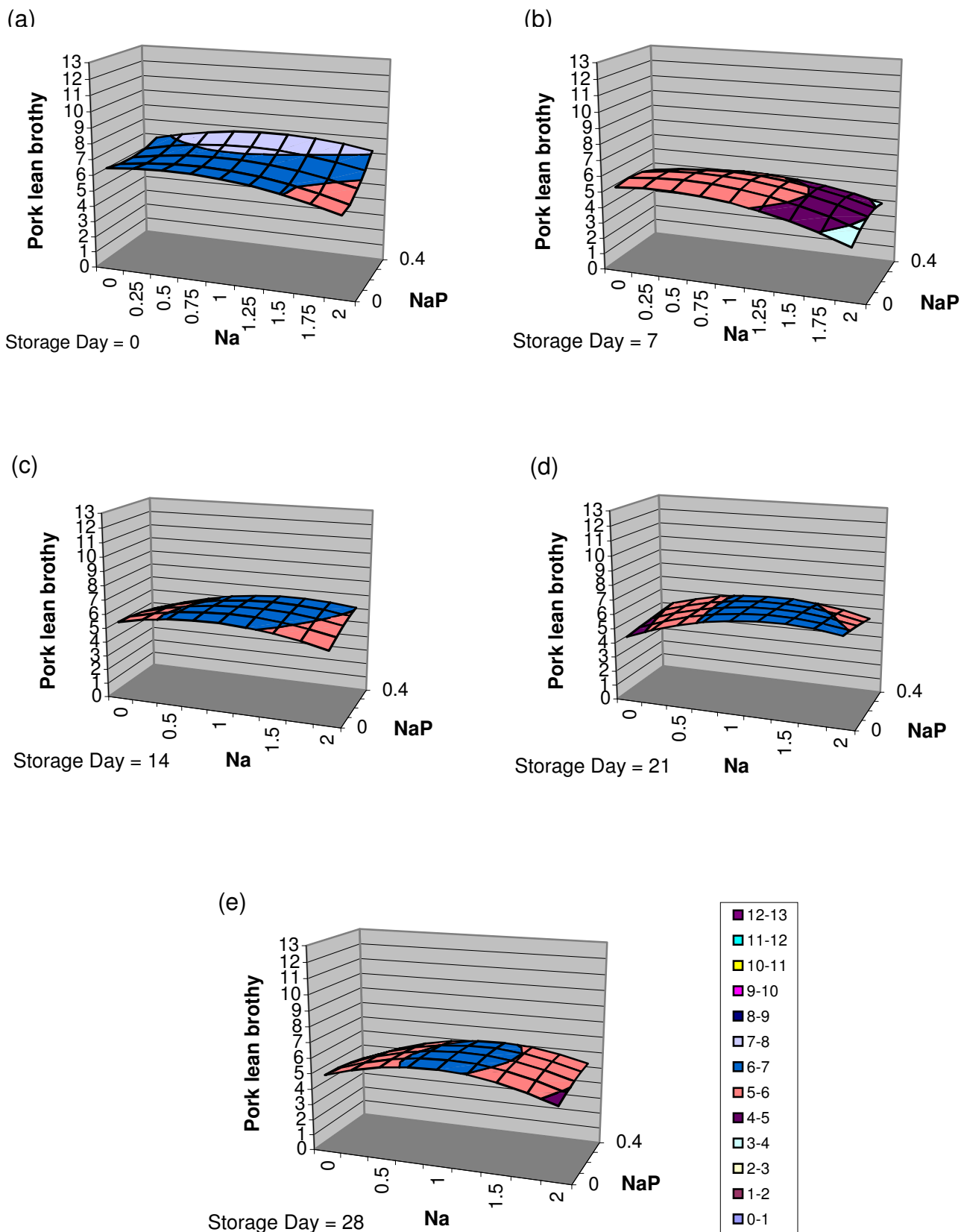


Figure 3. Effect of sodium phosphate (NaP) and salt (Na) levels on sensory pork lean/brothy of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 1.

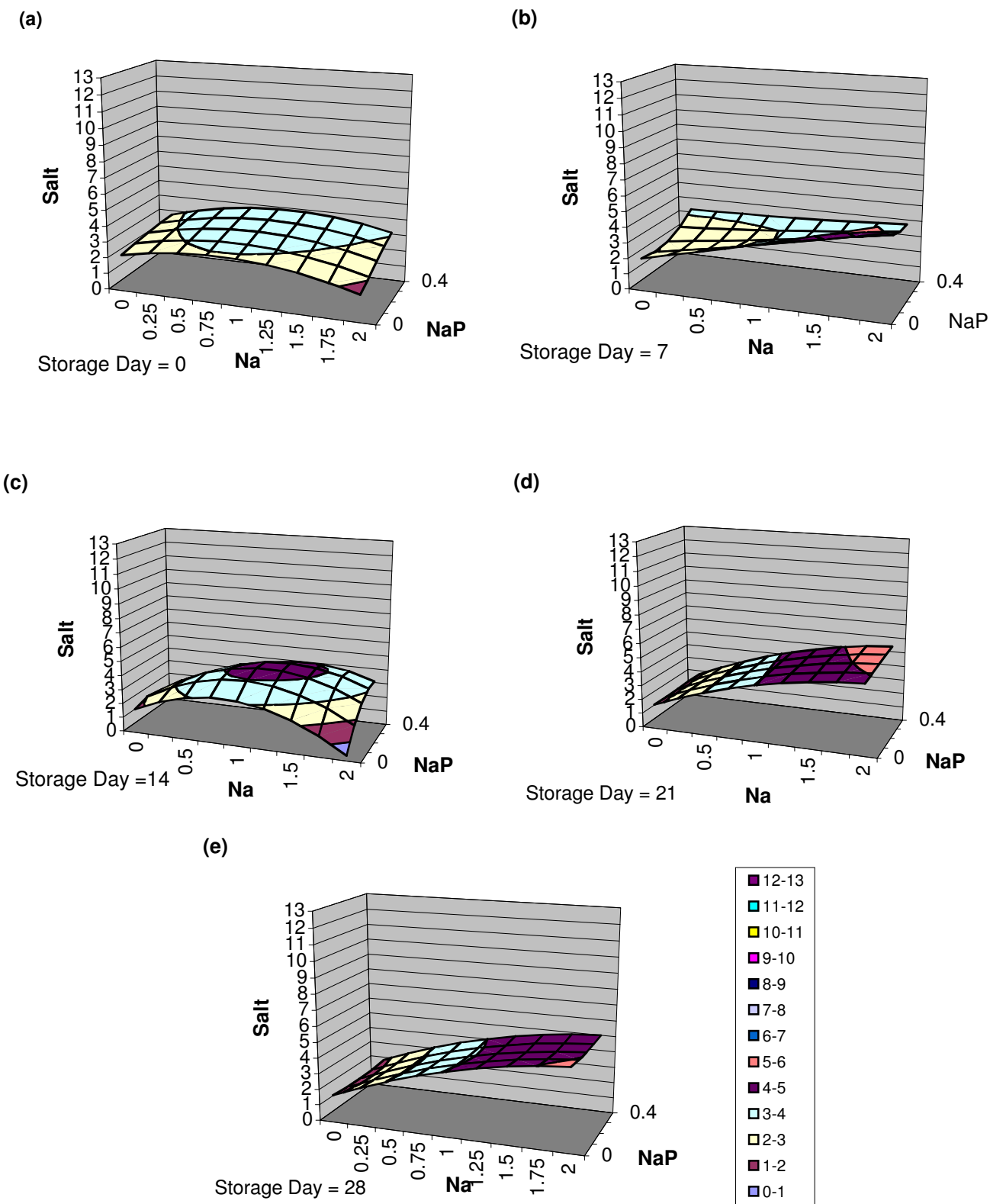


Figure 4. Effect of sodium phosphate(NaP) and salt (Na) levels on sensory salt basic taste of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 1.

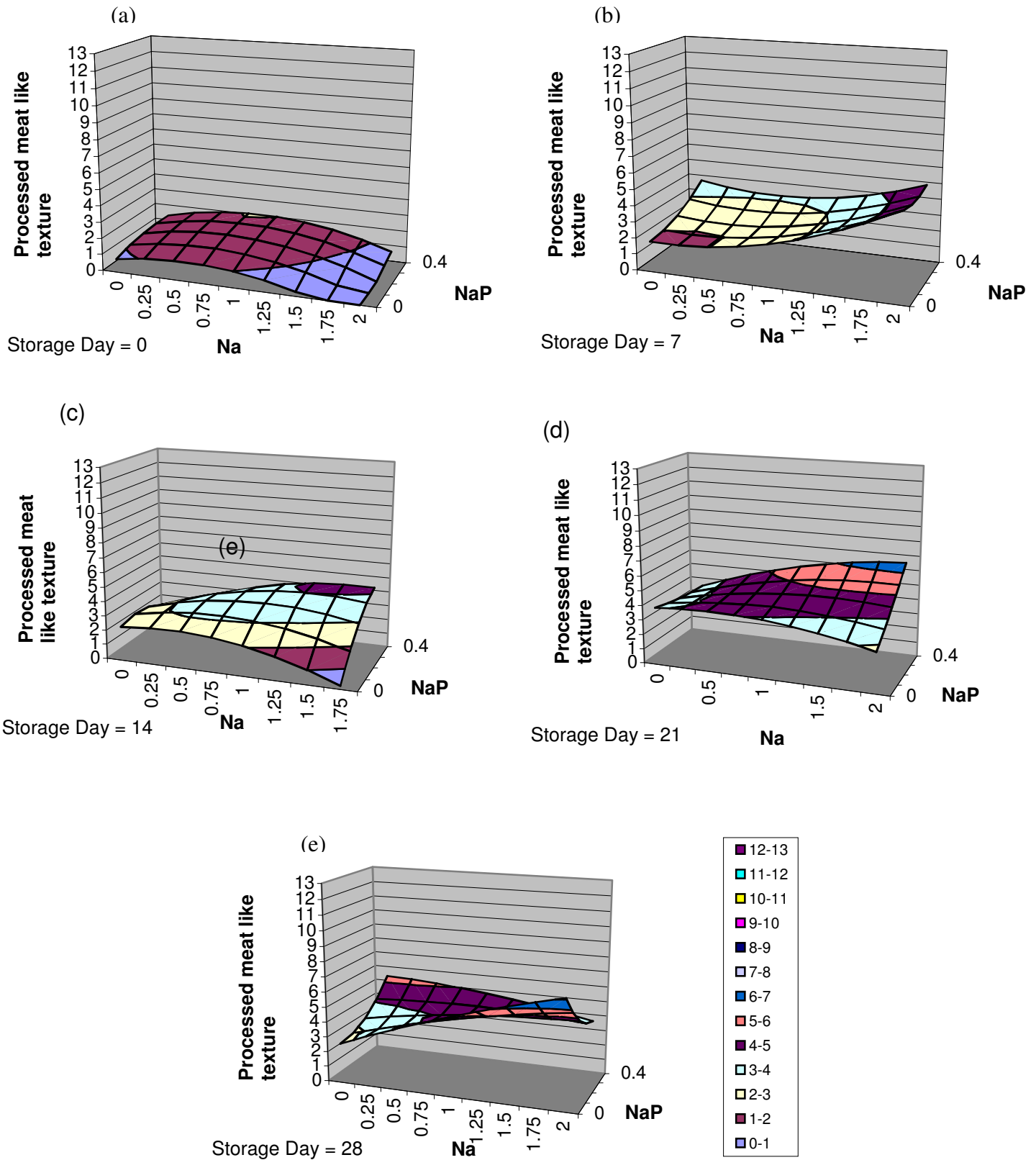


Figure 5. Effect of sodium phosphate (NaP) and salt (Na) levels on sensory processed meat-like bite (0=whole muscle or steak like; 15=very soft and rubbery) of pork loin chops stored at 0, 7, 14, 21 and 28 days at 4°C in Experiment 1.

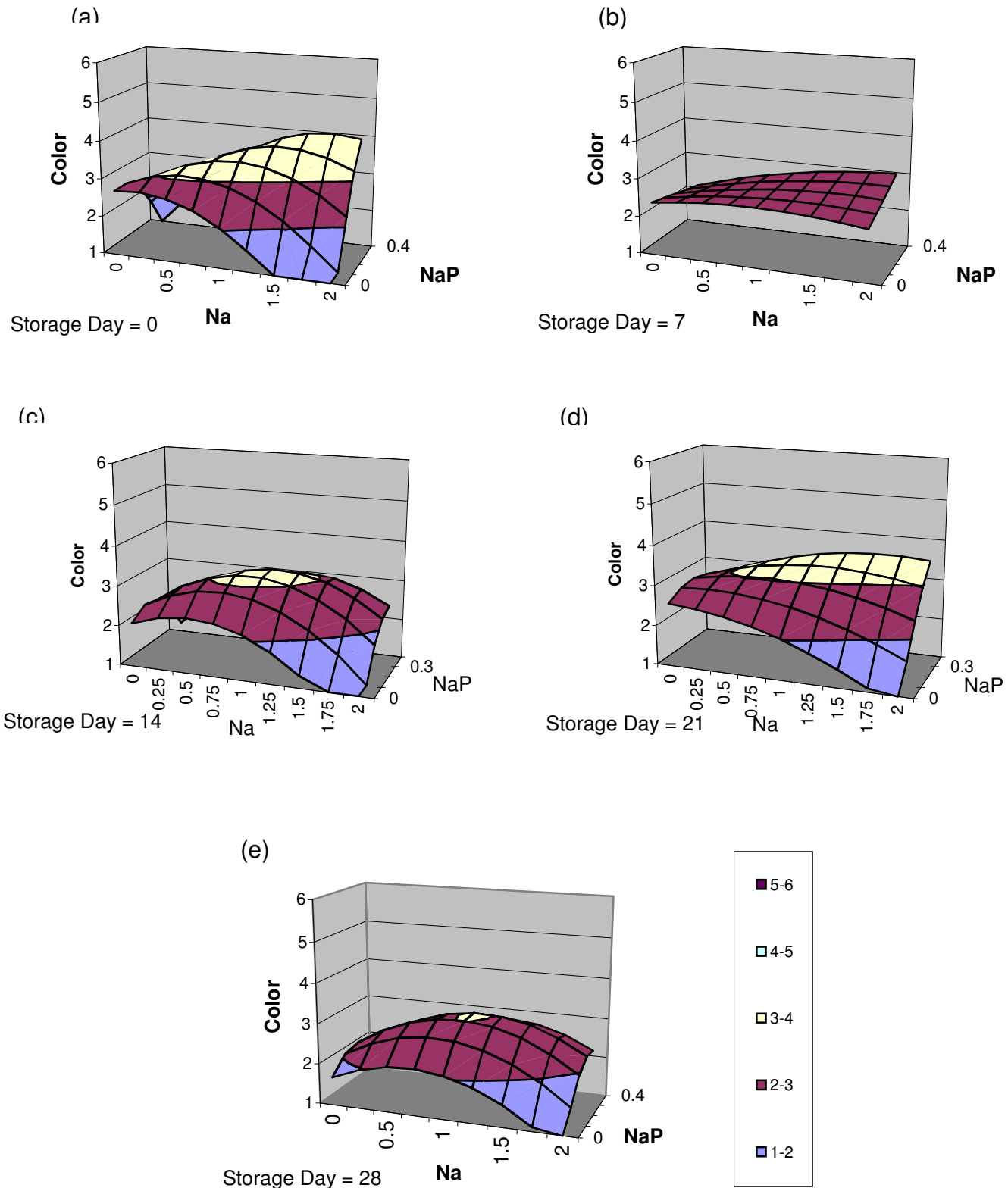


Figure 6. Effect of sodium phosphate (NaP) and salt (Na) levels on sensory color (1=pale pink; 6=dark, pinkish red) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 1.

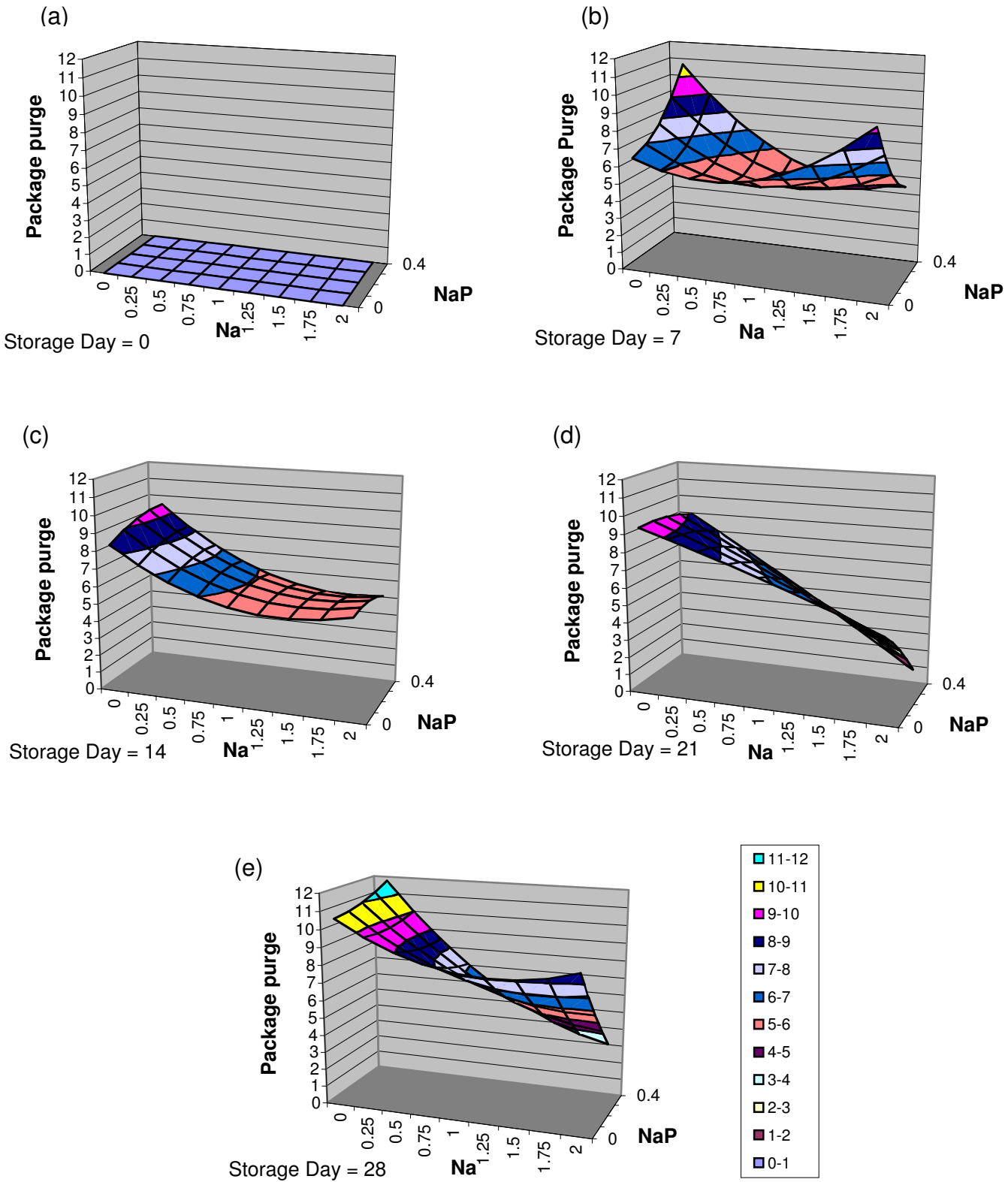


Figure 7. Effect of sodium phosphate (NaP) and salt (Na) levels on package purge of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 2.

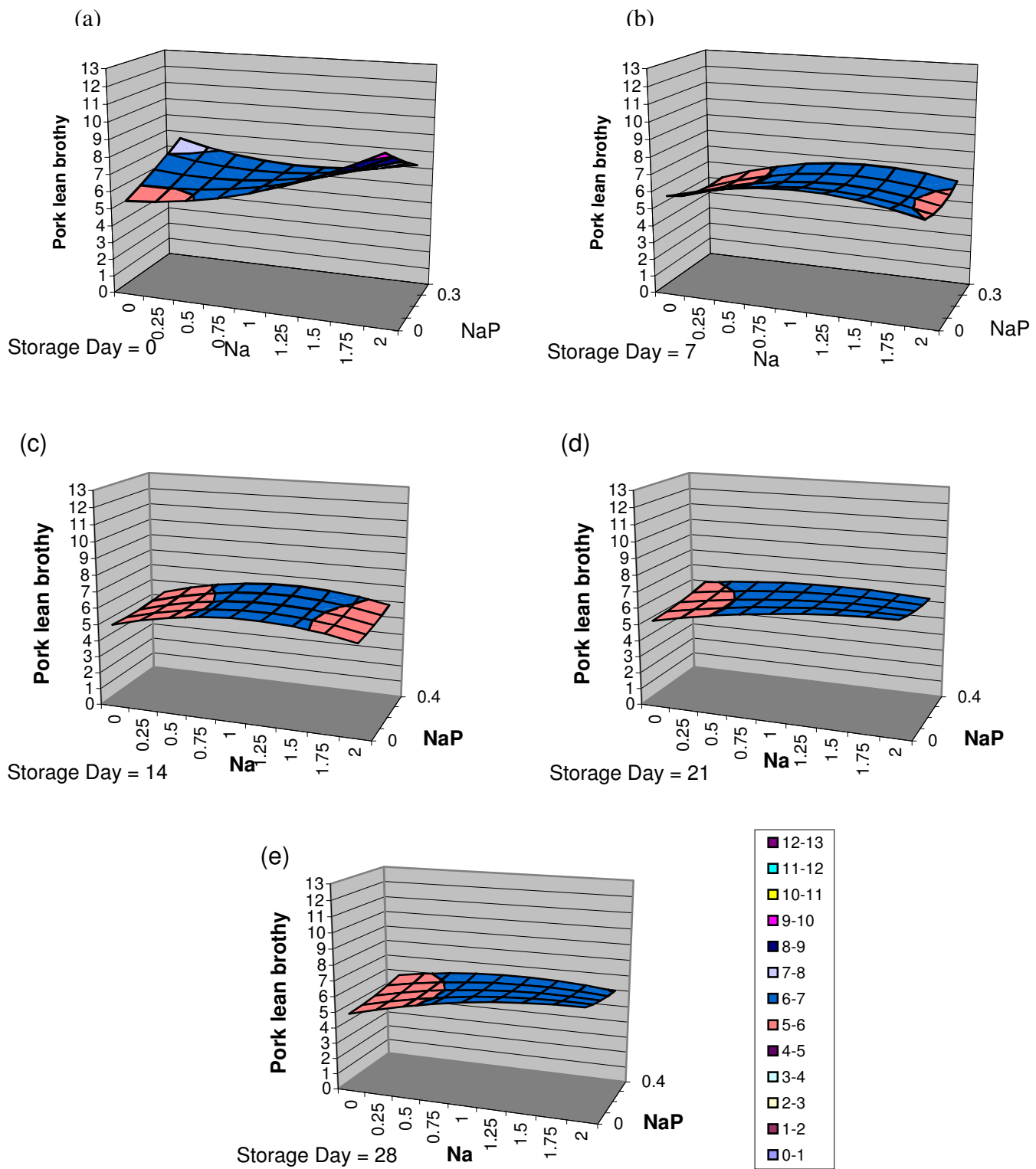


Figure 8. Effect of sodium phosphate (NaP) and salt (Na) level on sensory pork lean/brothy of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 2.



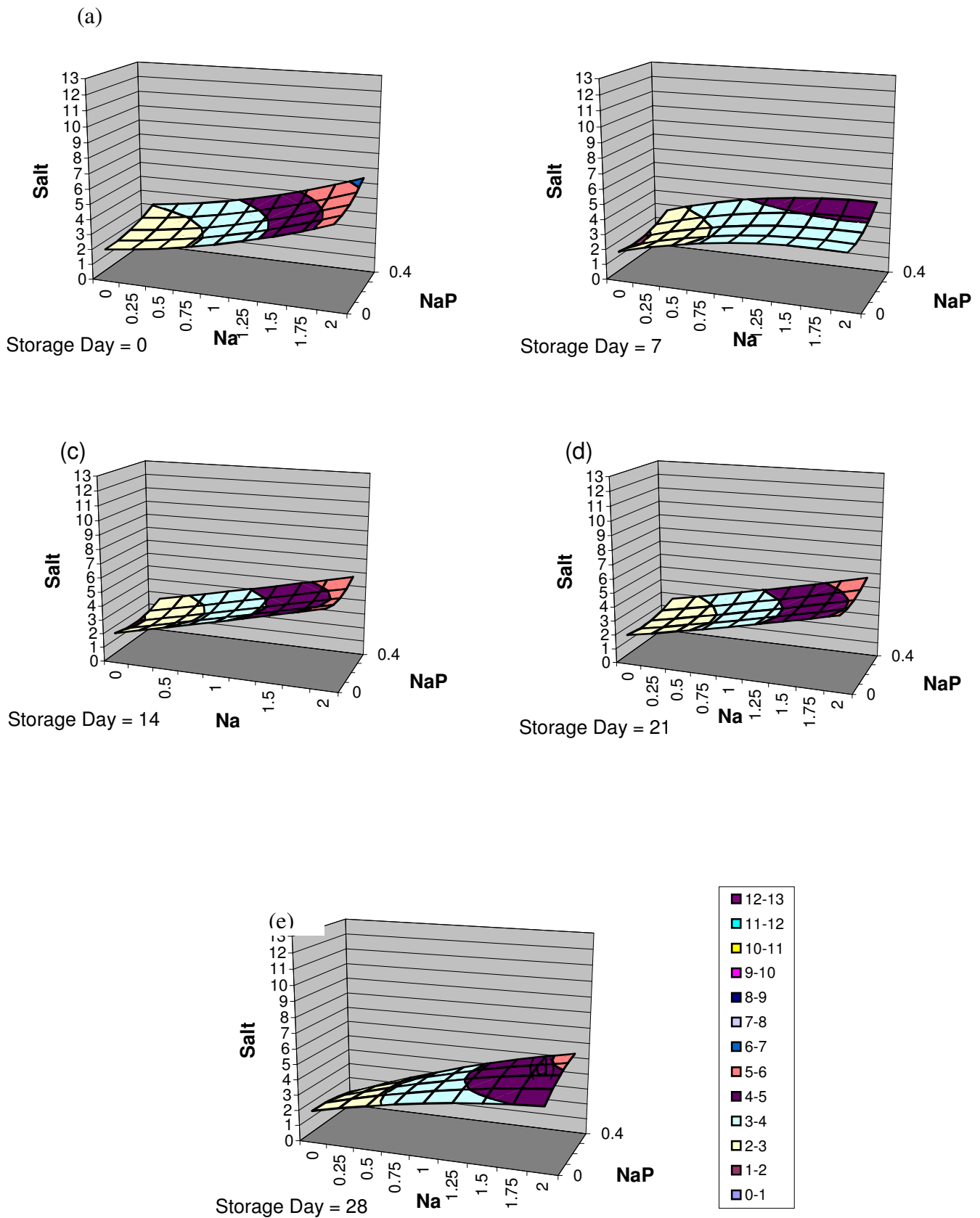


Figure 9. Effect of sodium phosphate (NaP) and salt (Na) levels on sensory salt basic taste of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 2.

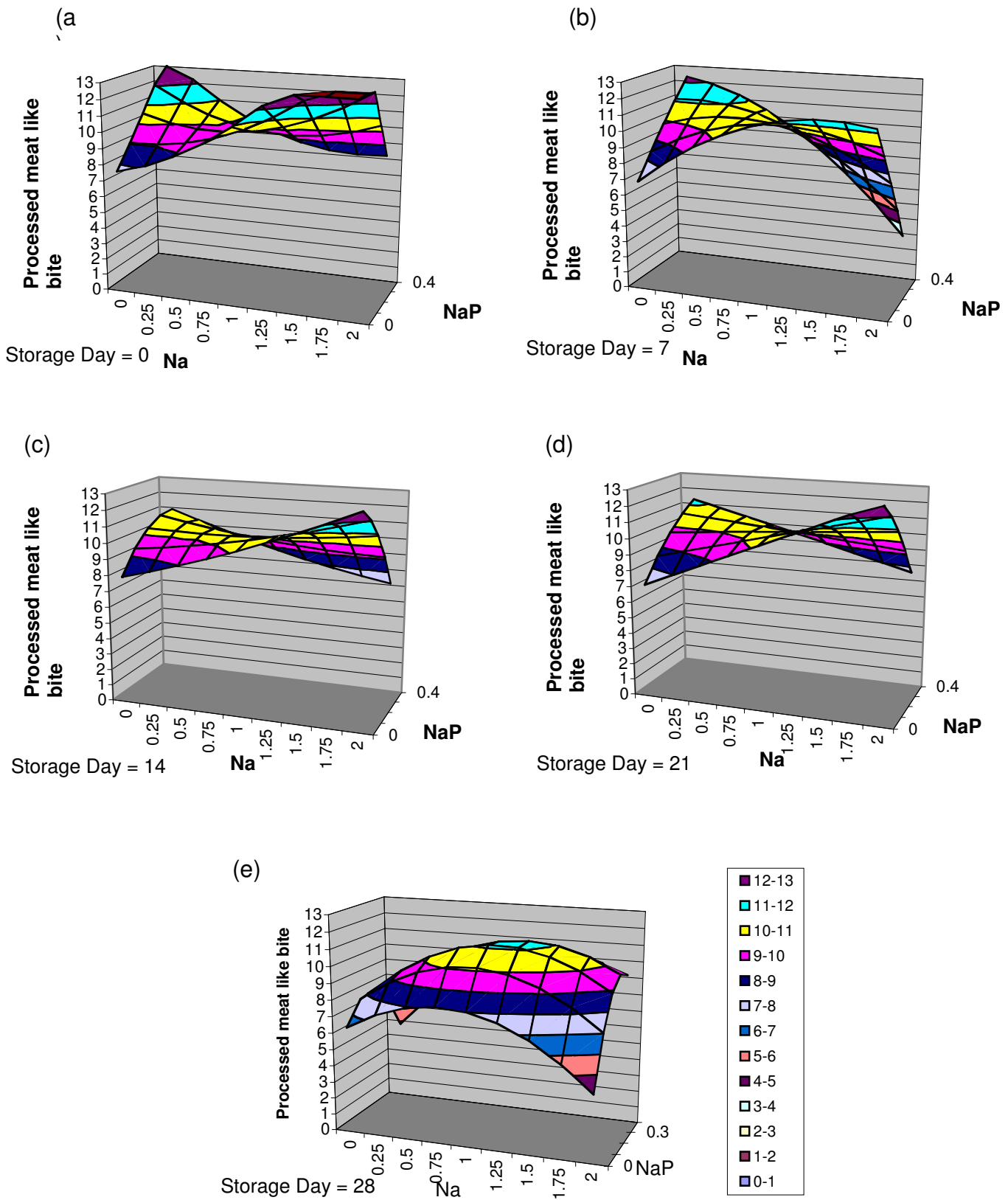


Figure 10. Effect of sodium phosphate (NaP) and salt Na levels on sensory processed meat-like bite (0=whole muscle or steak like; 15=very soft and rubbery) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 2.

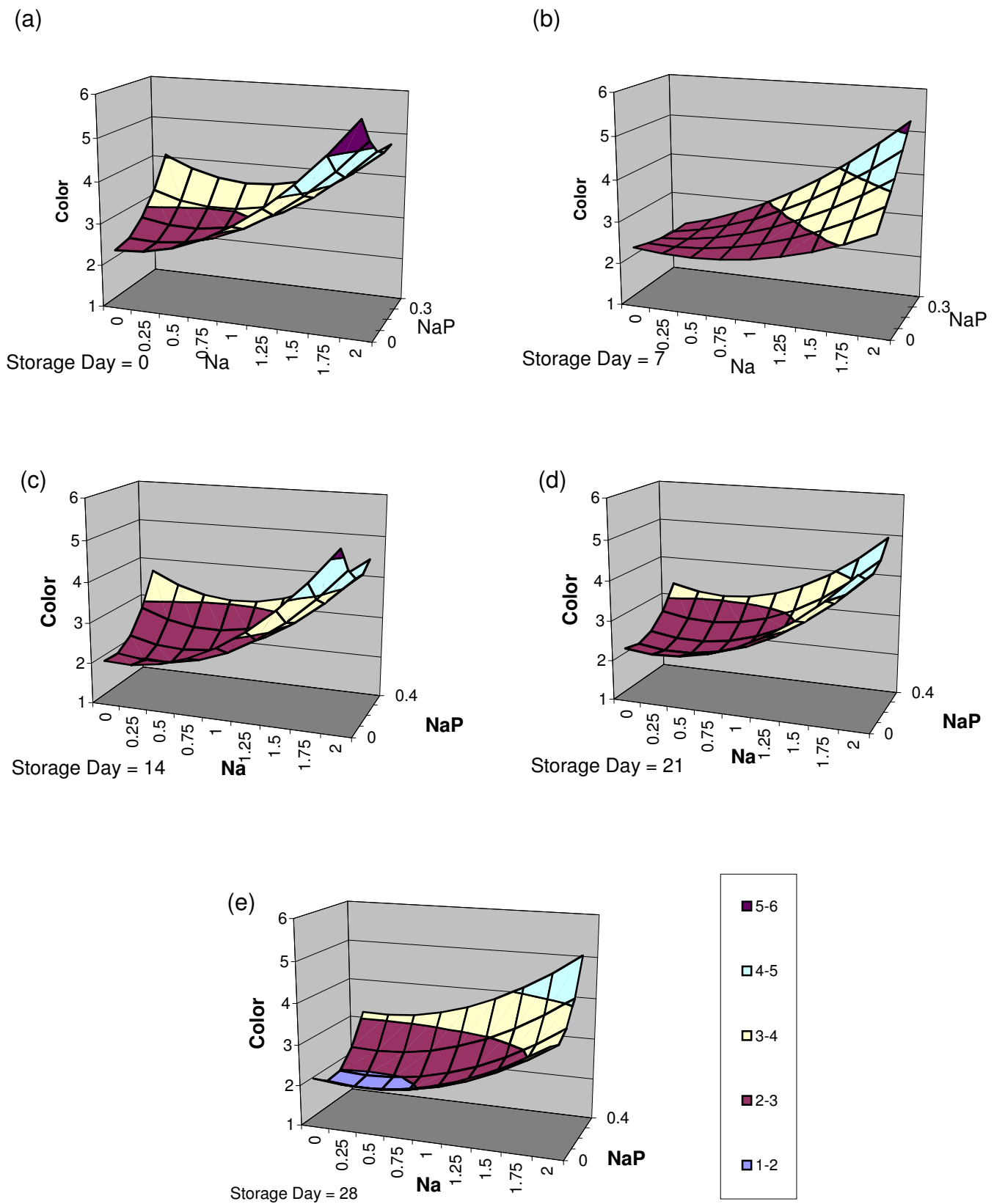


Figure 11. Effect of sodium phosphate and salt level on sensory color (1=pale pink; 6=dark, pinkish red) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 2.

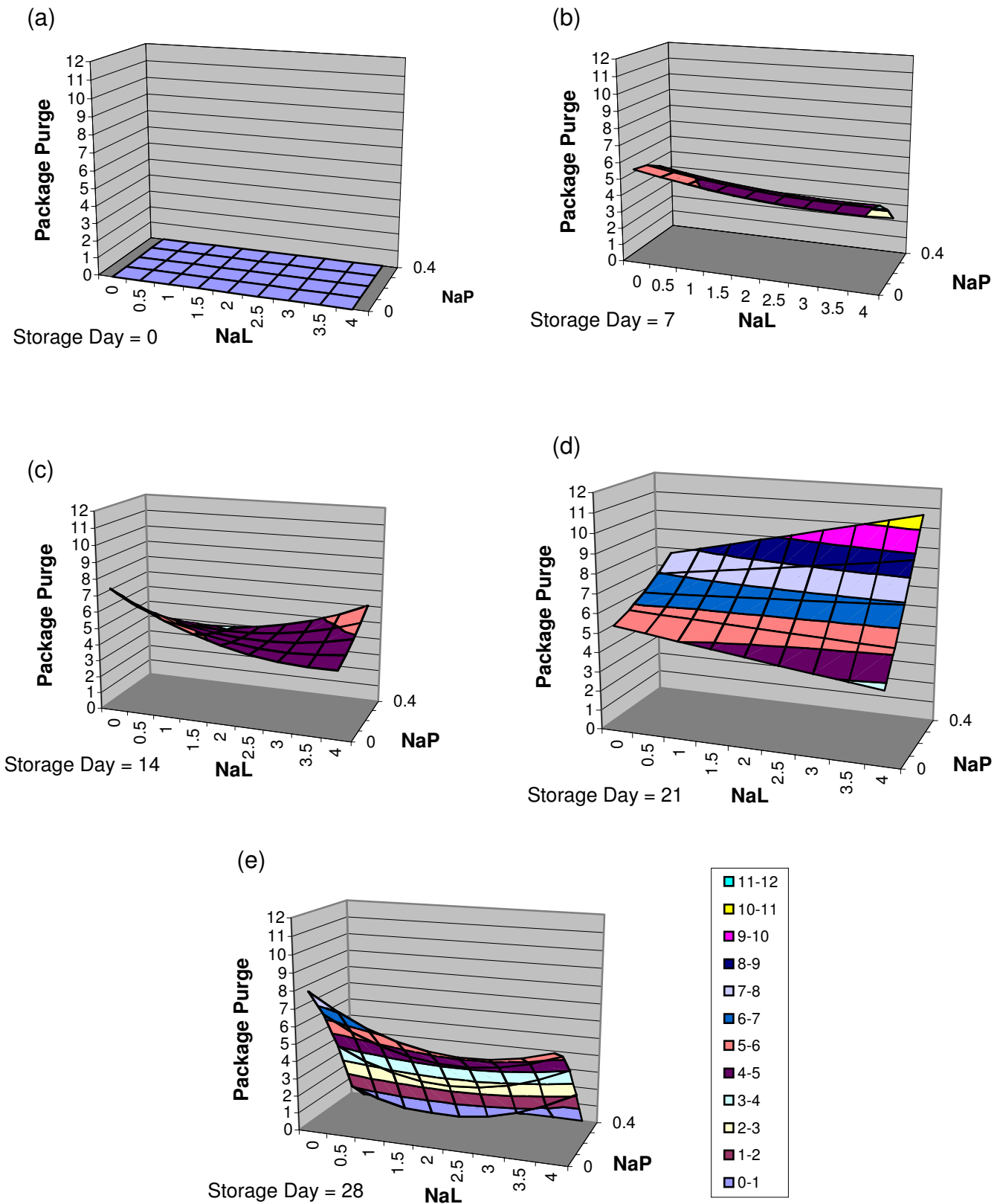


Figure 12. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on package purge of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 3.

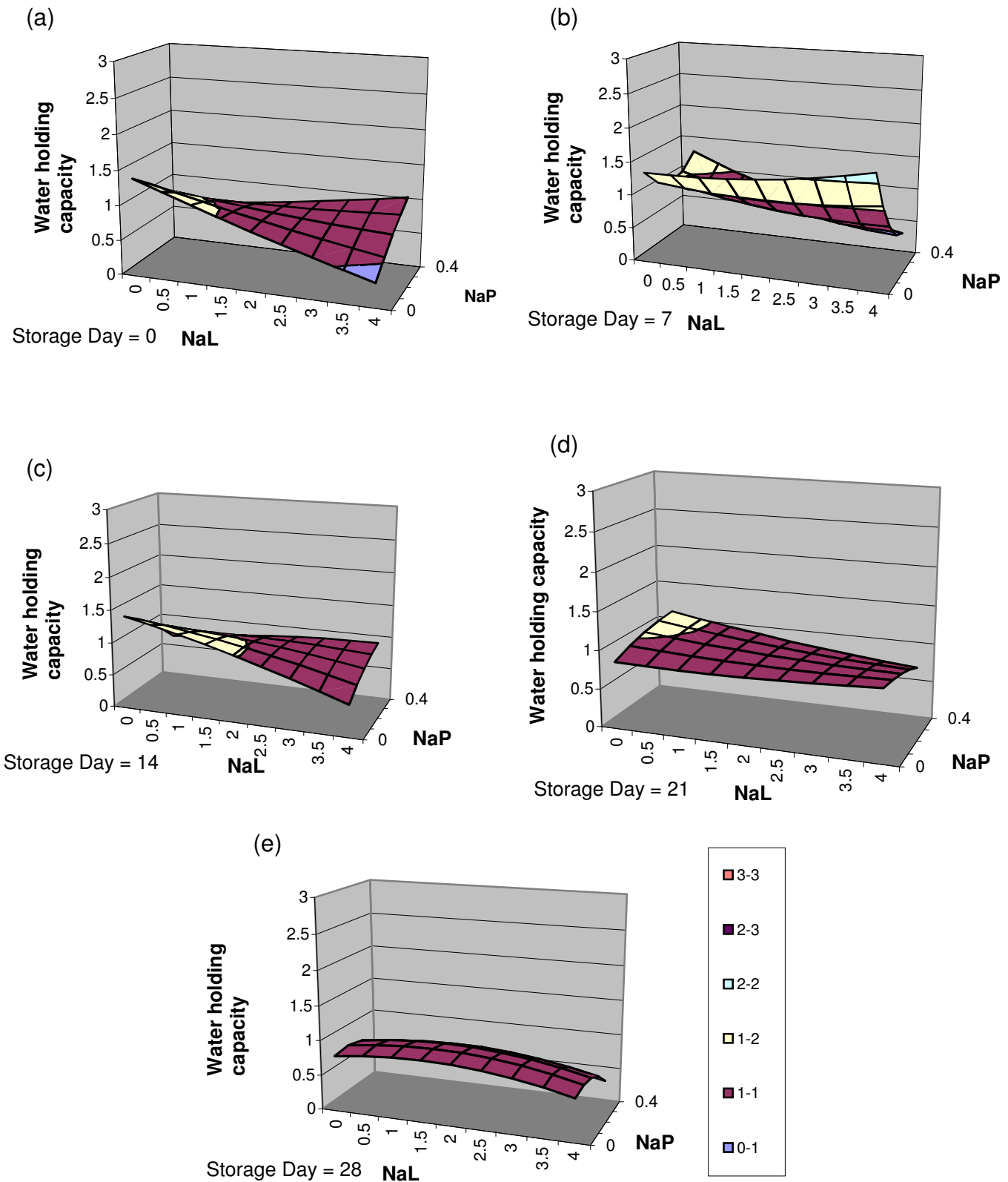


Figure 13. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on water holding capacity of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 3.

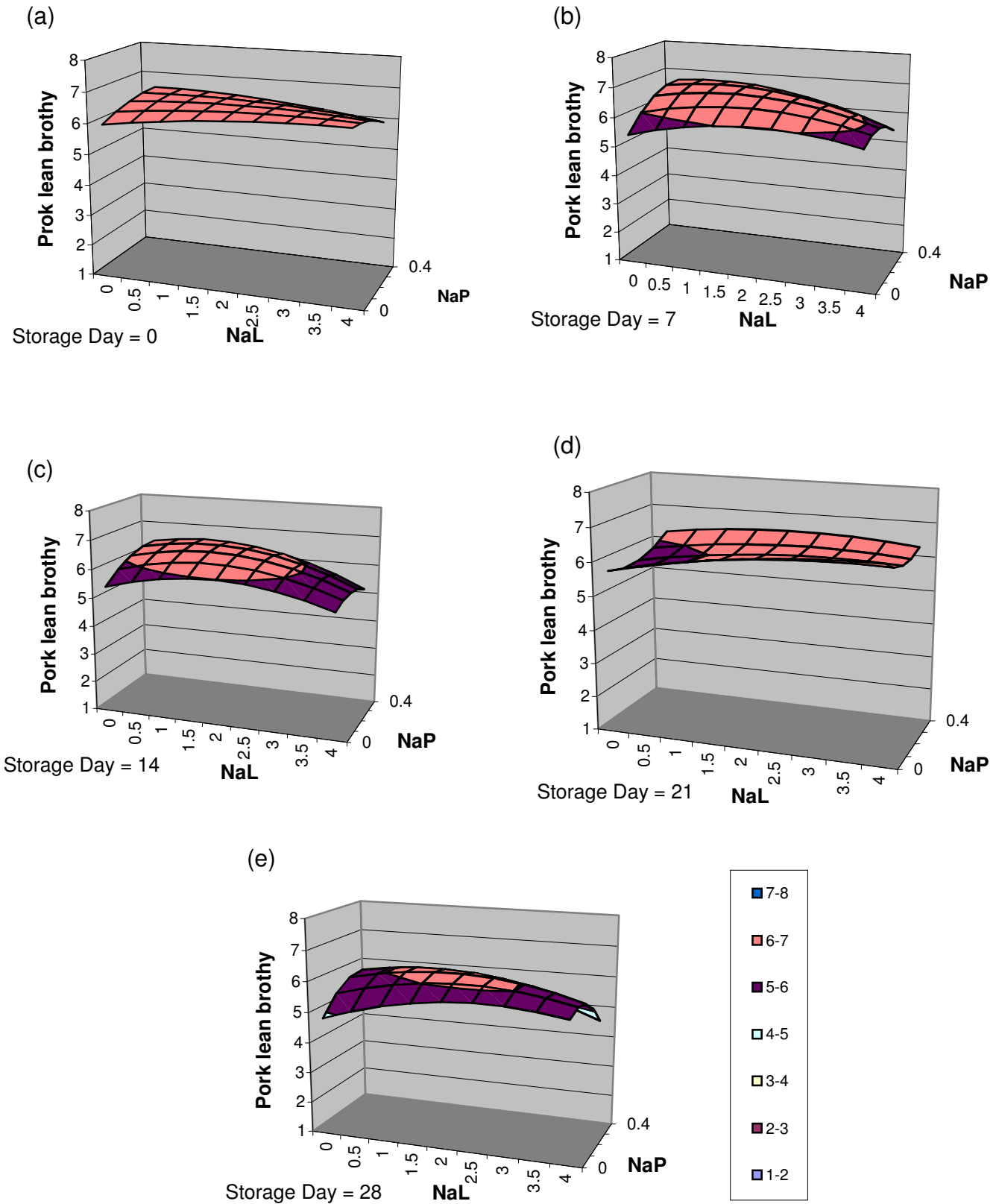


Figure 14. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on sensory pork lean/brothy of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 3.

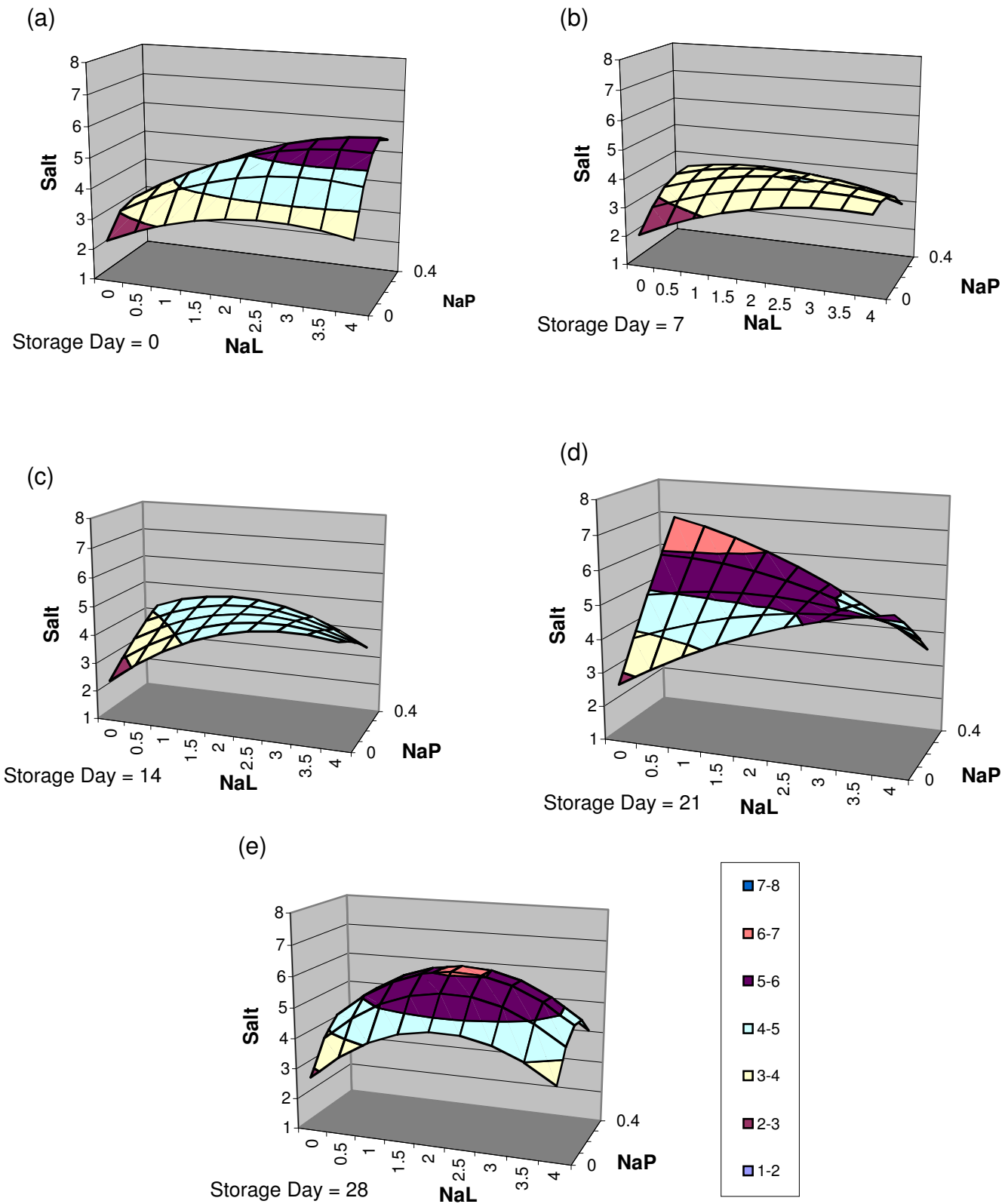


Figure 15. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on sensory salt basic taste of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 3.

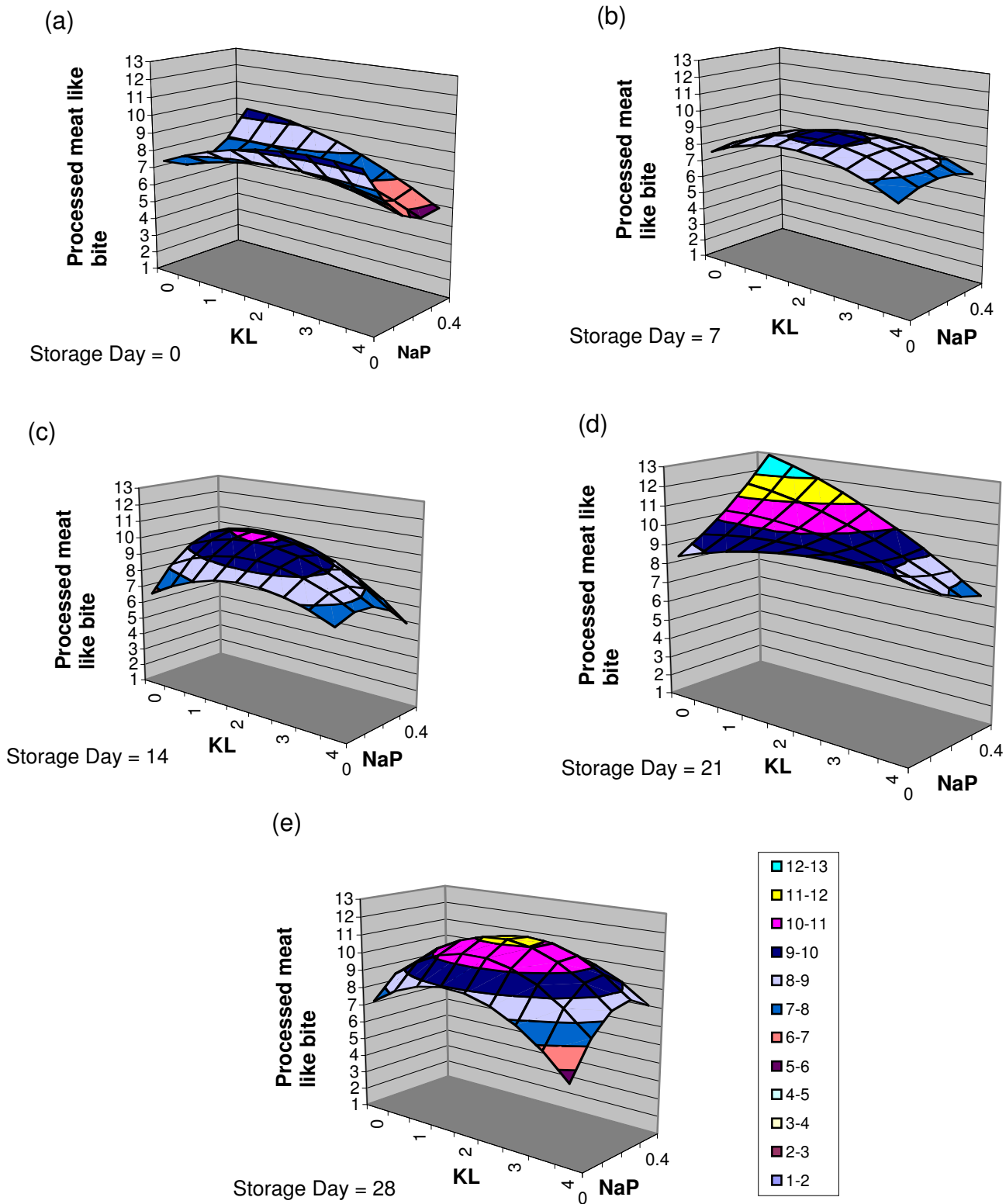


Figure 16. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on sensory processed meat-like bite (0=whole muscle or steak like; 15=very soft and rubbery) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 3.



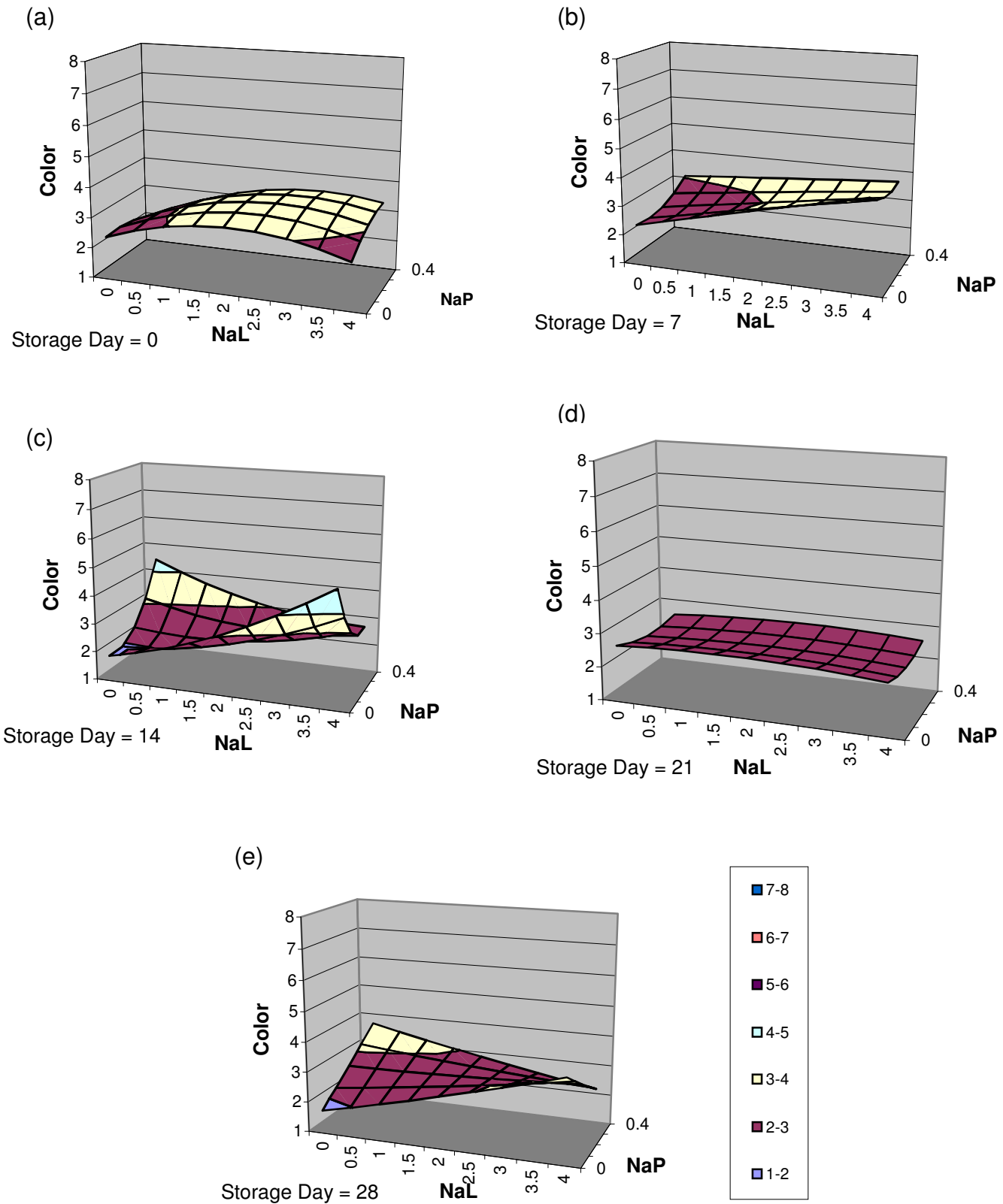


Figure 17. Effect of sodium phosphate (NaP) and sodium lactate (NaL) levels on sensory color (1=pale pink; 6=dark, pinkish red) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 3.

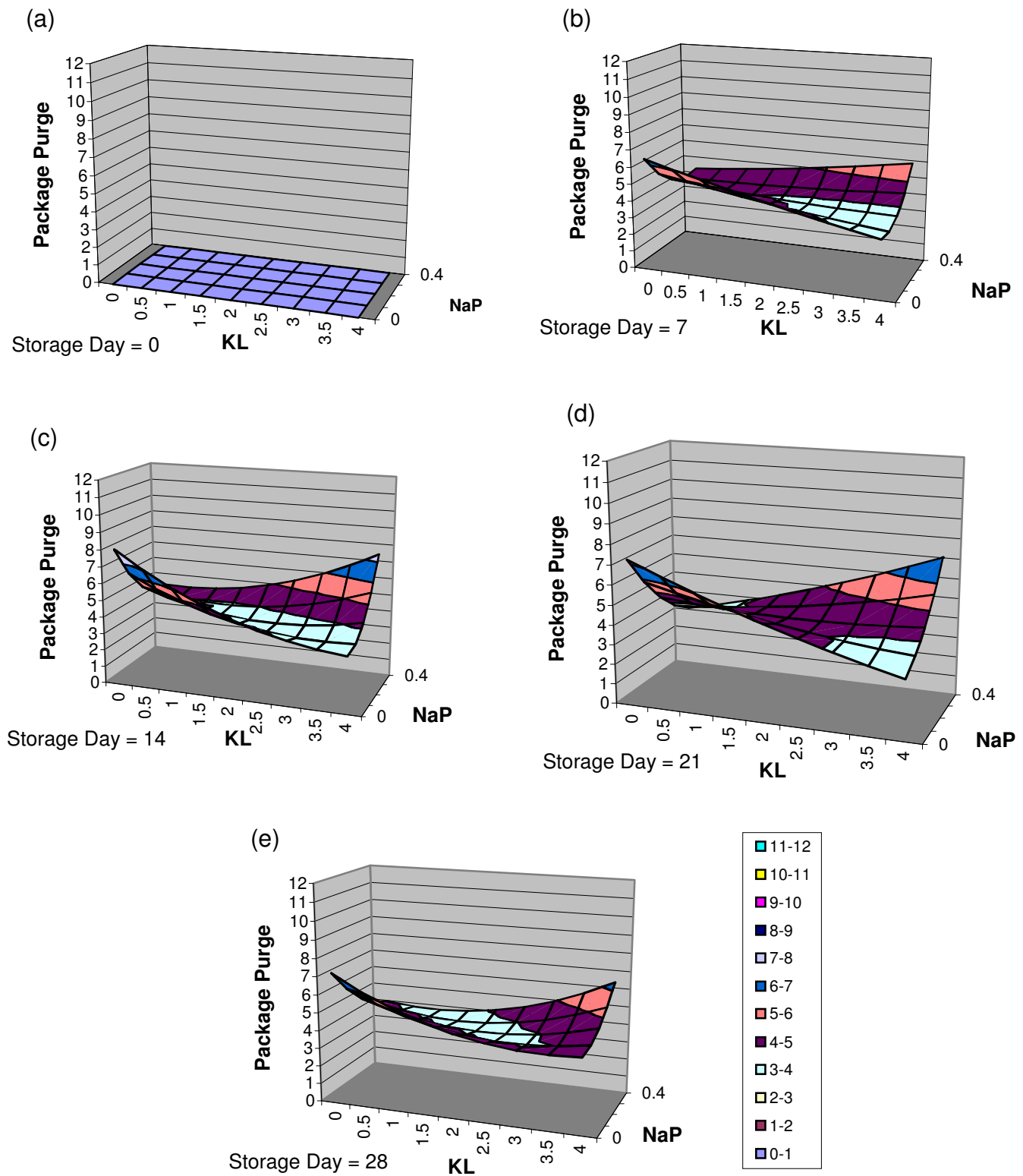


Figure 18. Effect of sodium phosphate (NaP) and potassium lactate (KL) levels on package purge of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 4.

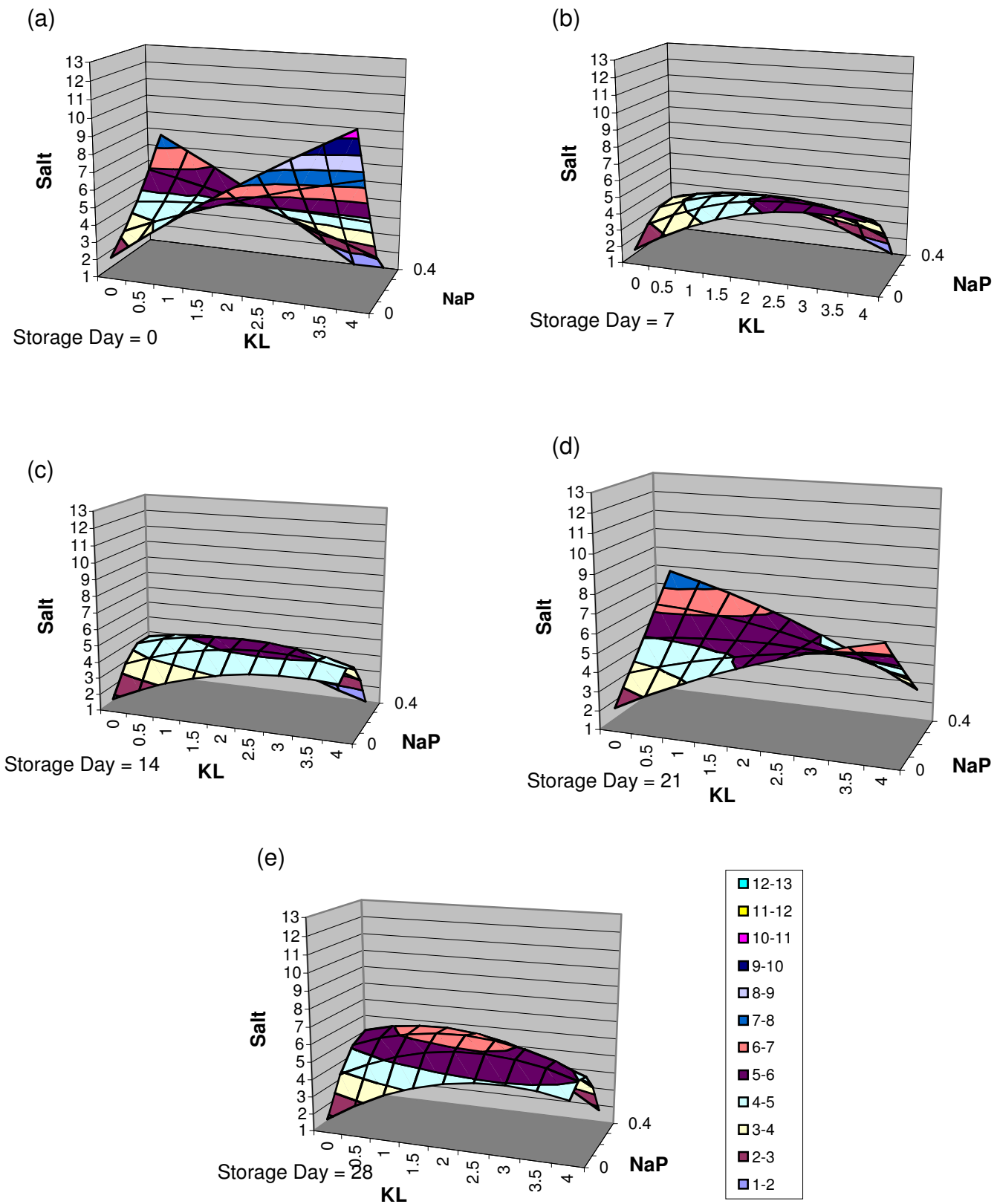


Figure 19. Effect of sodium phosphate (NaP) and potassium lactate (KL) levels on sensory salt basic taste of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 4.

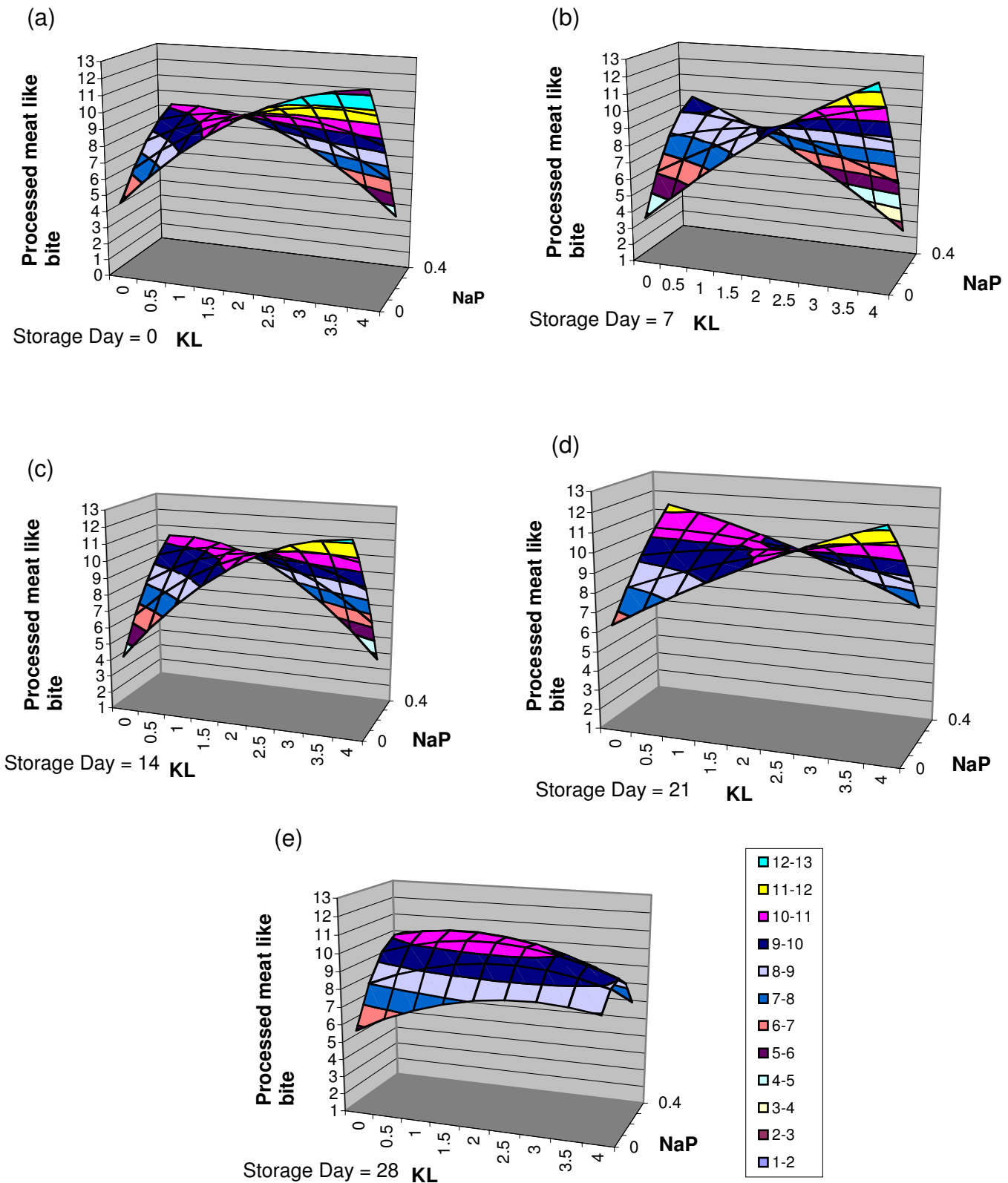


Figure 20. Effect of sodium phosphate (NaP) and potassium lactate (KL) levels on sensory processed meat-like bite (0=whole muscle or steak like; 15=very soft and rubbery) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 4.

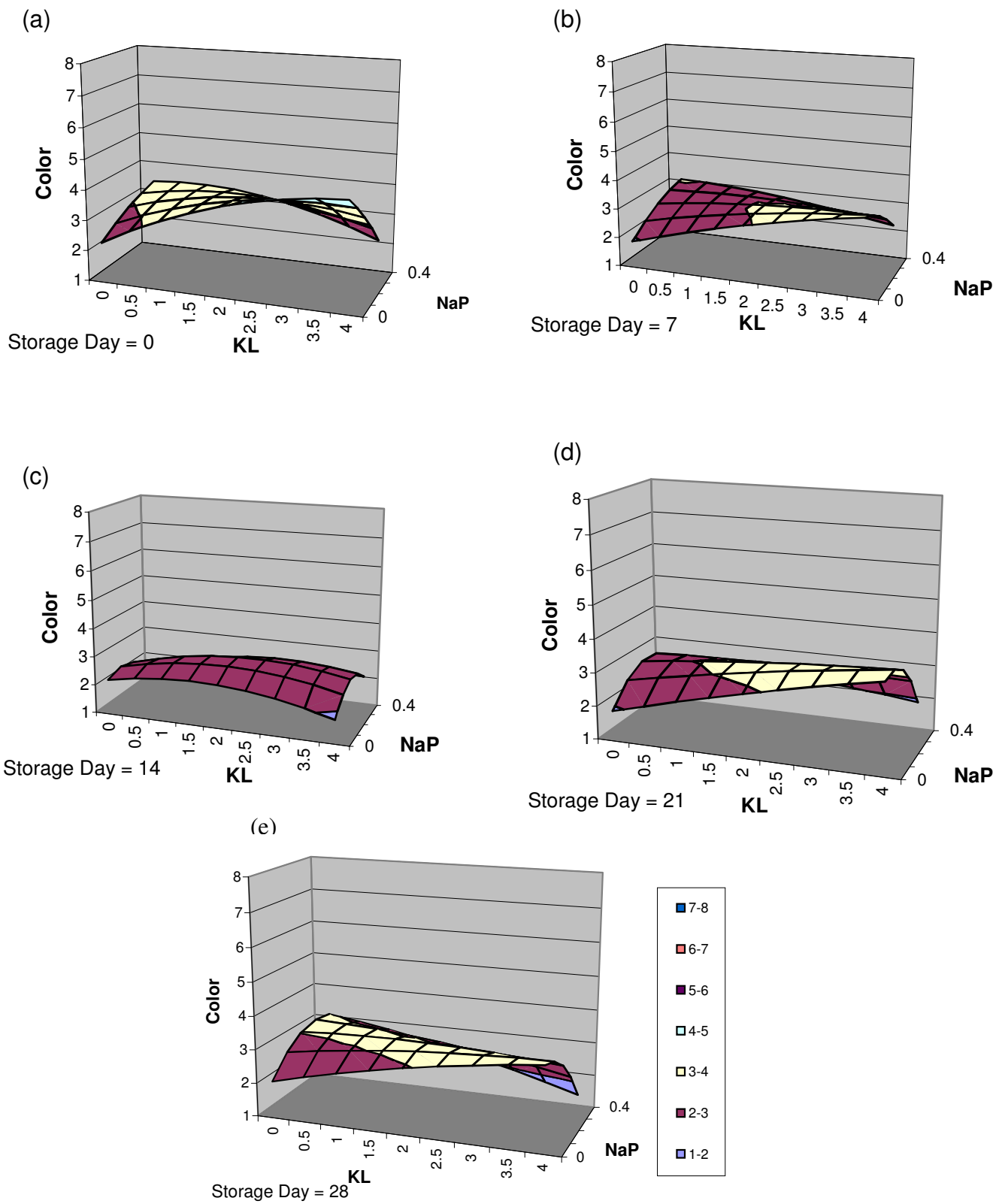


Figure 21. Effect of sodium phosphate (NaP) and potassium lactate (KL) levels on sensory color (1=pale pink; 6=dark, pinkish red) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4 °C in Experiment 4.

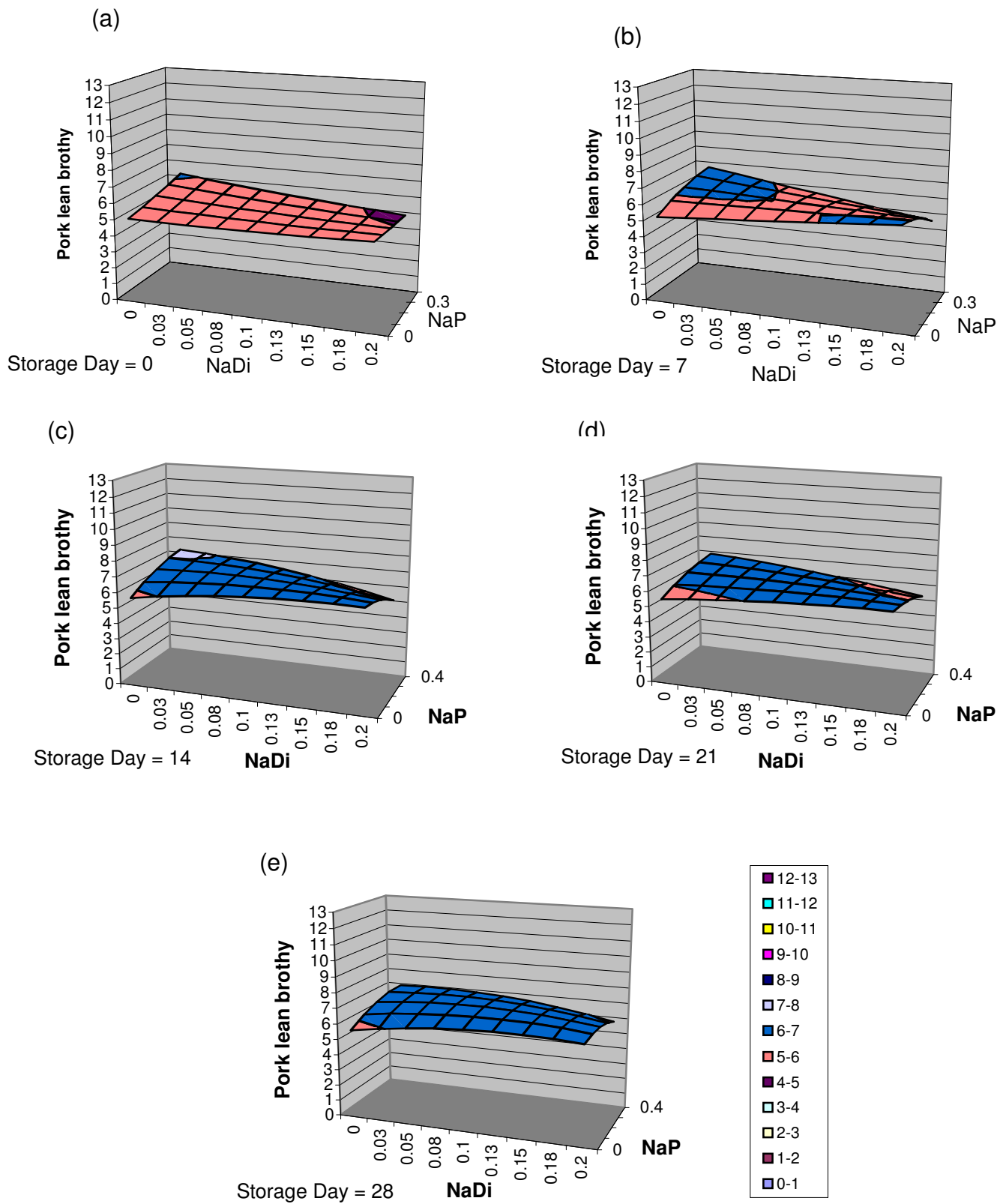


Figure 22. Effect of sodium phosphate (NaP) and sodium diacetate (NaDi) levels on sensory pork lean/brothy of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 5.

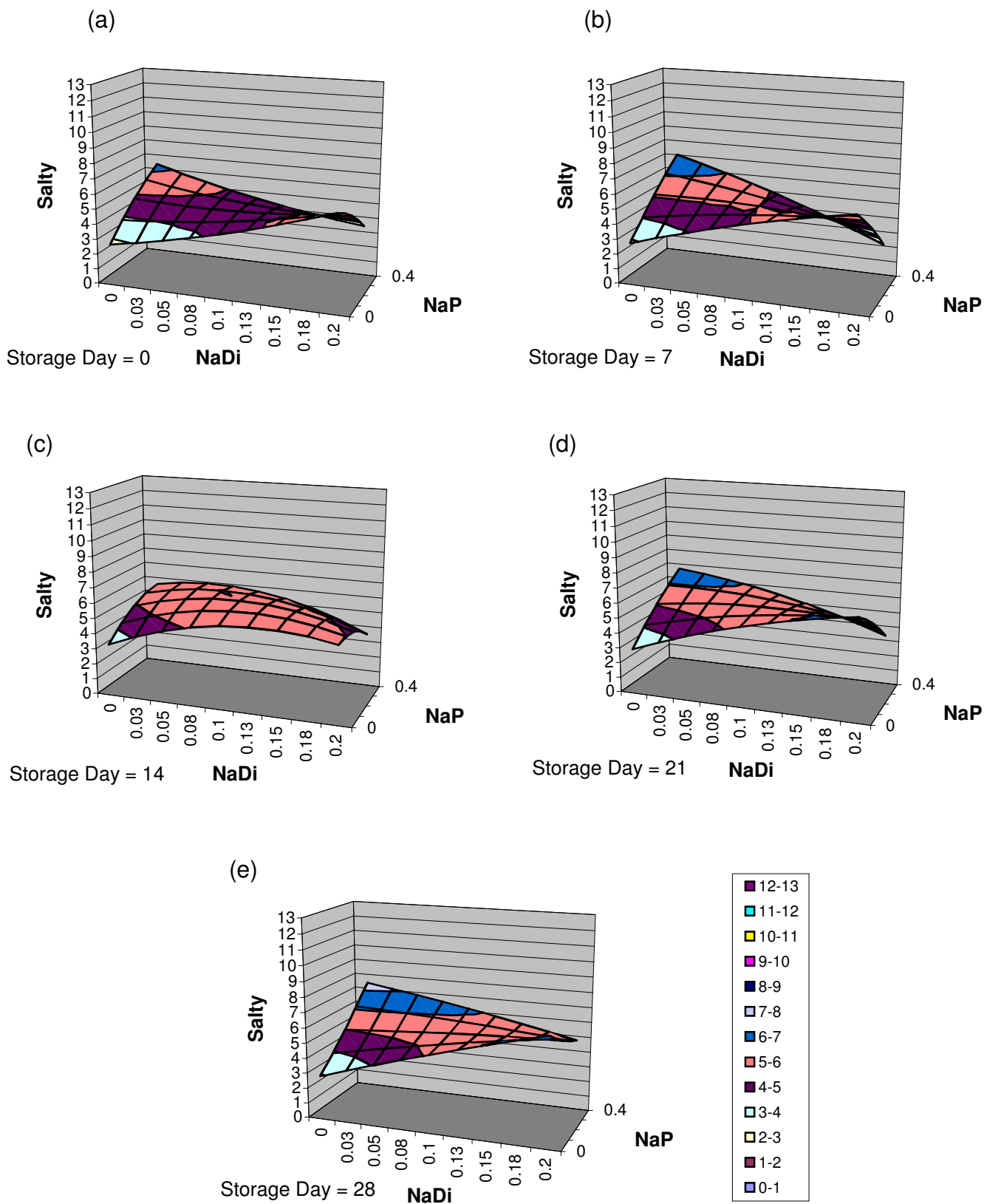


Figure 23. Effect of sodium phosphate (NaP) and sodium diacetate (NaDi) levels on sensory salt basic taste of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 5.

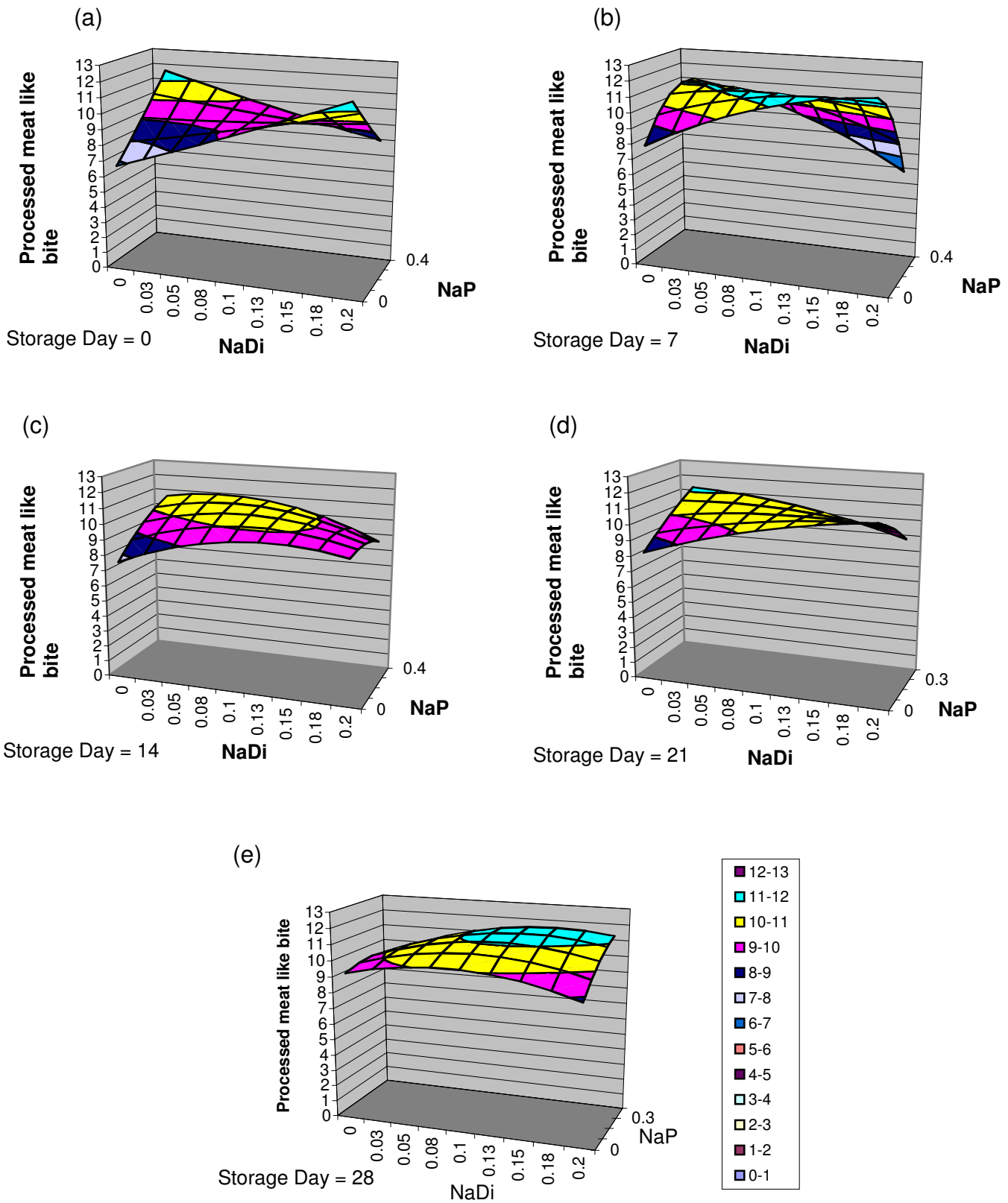


Figure 24. Effect of sodium phosphate (NaP) and sodium diacetate (NaDi) levels on sensory processed meat-like bite (0=whole muscle or steak like; 15=very soft and rubbery) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 5.



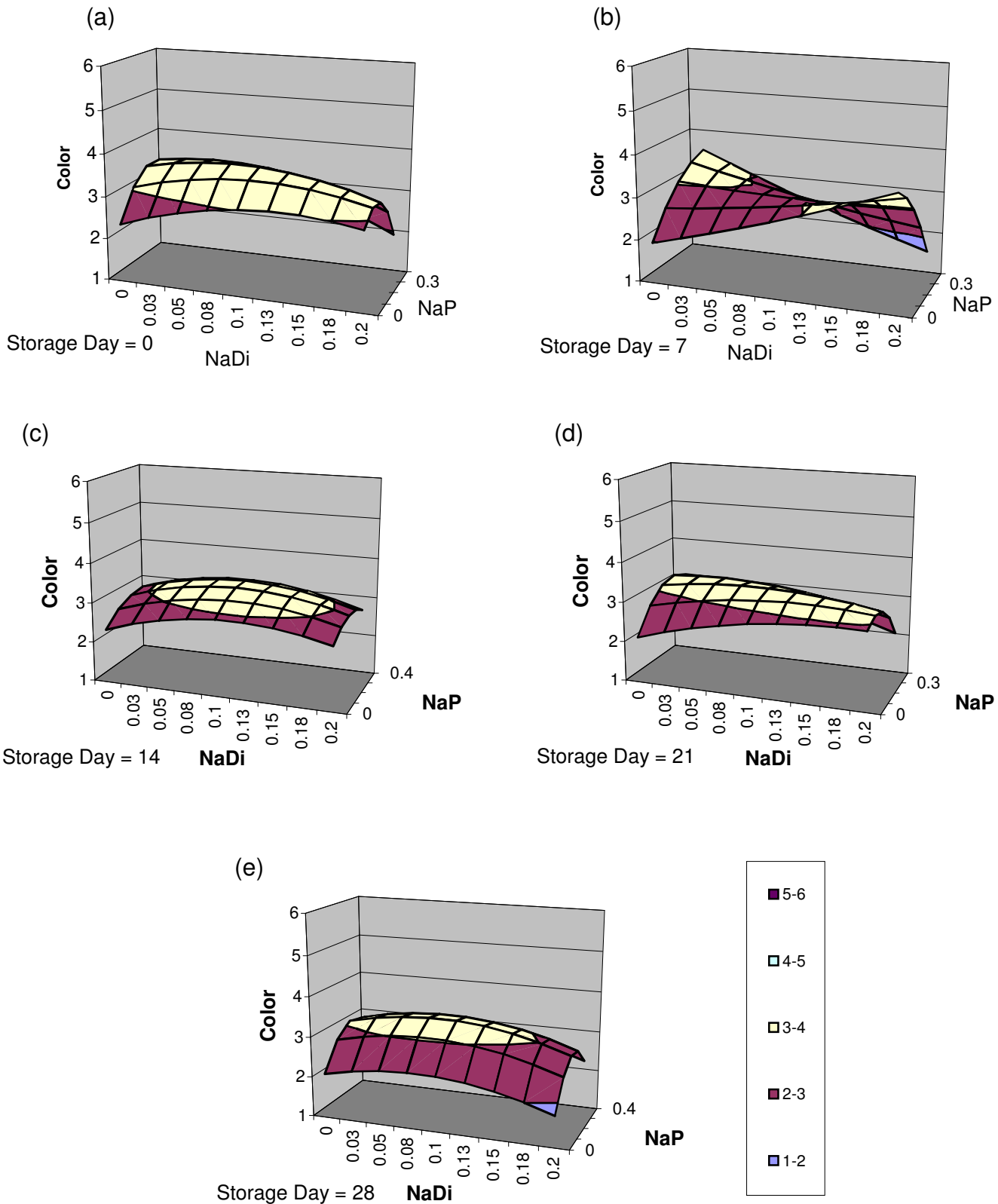


Figure 25. Effect of sodium phosphate (NaP) and sodium diacetate (NaDi) levels on sensory color (1=pale pink; 6=dark, pinkish red) of pork loin chops stored at 0 (a), 7 (b), 14 (c), 21 (d) and 28 (e) days at 4°C in Experiment 5.

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