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A SENSORY PERSPECTIVE OF EFFECT OF FEEDS ON FLAVOR IN MEATS: POULTRY MEATS[1,2]

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ABSTRACT

Reduction of feed costs is a major concern of poultry producers. However, replacement of components of a corn-soybean diet with a lower-cost alternative requires the assessment not only of poultry performance and carcass characteristics but also of resulting meat quality. A brief overview of research studies, conducted over the past 10 yr, investigating the effects of alternative poultry feedstuffs on poultry meat flavor is presented. The primary focus is on the sensory analysis technique employed in these studies to evaluate flavor. The studies discussed include examinations of poultry diets that contain various levels of rapeseed meal, fishmeal and other feed additives. Diversity of the sensory techniques used illustrates the difficulty of comparing sensory results among studies. This difficulty is emphasized further with an example of how two different sensory sample preparation techniques affected the conclusion drawn from replicate studies of poultry diets supplemented with fishmeal (0, 4, 8 and 12%). One of the replicates was cooked and sampled for sensory analysis; the other was placed in 4°C storage overnight. For the samples tested immediately following cooking, no difference between the treatments was detected. However, when the samples were tested following overnight storage (4°C), chicken flavor decreased ($P < .001$) and fish-off flavor increased ($P < .001$) as percentage of fish meal in the diet increased.

(Key Words: Feeds, Flavor, Poultry, Sensory Evaluation.)

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Introduction

Reduction of feed costs is a major concern of poultry producers. Replacement of components of a corn soybean diet with a lower-cost alternative requires the assessment not only of the poultry performance and carcass characteristics but also of the resulting meat quality.

In 1975 (deBoer, 1975), a recommendation was made "to establish a working group to discuss problems involved in meat quality assessments and to assist in the development of good baseline sensory methods." The need for good sensory analysis techniques was further emphasized in a recent seminar organized by a food industry trade publisher wherein it was concluded that "taste" would continue to be the driving force in the food processing industry for the 1990s and beyond (Duxbury, 1988).

Often, a research protocol is established based on knowledge gained through a literature search. Critical evaluation of the published sensory procedures is essential in developing a sound knowledge base from which to prepare future research protocols. If this is not done, then a protocol may be developed based on some other author's incorrect procedures.

In the review for this paper, many examples of improper use of test methods, improper use

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of scales, little or no control over experimental conditions, little (if any) description of sample preparation and presentation techniques, and incorrect interpretation of results were encountered.

The purpose of this paper is to give a brief review of research on alternative poultry feeds as they affect poultry meat flavor with particular emphasis on sensory analysis. In addition, an example of replicate experiments is provided to demonstrate the importance of the effects of the sensory analysis technique on the results.

Literature in Brief

A literature search conducted for the purposes of this paper identified 22 published papers since 1979 reporting flavor evaluation of poultry; 6 involved turkeys, the other 16, chickens. A brief overview of the past 10 yr of research on the effect of alternative poultry feedstuffs demonstrates a diversity of sensory procedures. Such diverse approaches makes it difficult to draw comparisons both within one author's work and among studies.

Turkey. In the six studies conducted on turkeys, the feed elements examined were vitamin E (Bartov et al., 1983), canola meal (Salmon et al., 1988), live yeast culture (Savage et al., 1985), yellow peas (Savage et al., 1986), and triticale (Savage et al., 1987). Each study described a sensory methodology, albeit all were different. Bartov et al. (1983), using a consumer affective testing approach, concluded that the addition of vitamin E during the last 4 wk of feeding will provide full protective effect against lipid oxidation without affecting flavor quality. The sensory analysis used was a tri-hedral test (Basker, 1980, 1981) for identification tests, preference tests, preference ranking, non-parametric ratings and parametric scores. Preparation of the turkey involved cooking the breast and thigh meat in mildly spiced water.

The unusual testing approach (i.e., uncommon scales, consumer/affective) and sample preparation technique (spiced boiling water) makes it very difficult to make comparisons with the other laboratory studies on turkey flavor.

Comparison of the Larmond et al. (1983) and Salmon et al. (1988) studies was possible because they had common methodologies. The approach consisted of oven roasting at 162 to 163°C until an internal breast temperature of 85°C was attained. The ballot sheet for both studies was composed of 15-cm unstructured line scales (Larmond, 1977) including the attributes of flavor and off-flavor. Testing for both studies was done at the Food Research Centre, Ottawa. Results of Larmond et al. (1983) indicated there was no difference ($P > .05$) in flavor (8.1 vs 7.7 ± .20 for control vs canola meal) or off-flavor with canola meal incorporated in the diet at up to 21.1%. In contrast, Salmon et al. (1988) demonstrated a decrease ($P < .05$) (8.1 vs 7.3 ± .23 for control vs canola meal) in breast meat flavor scores at 20% canola meal. The greater effect found by Salmon et al. (1988) could be due to the use of more experienced panelists.

The three remaining turkey studies were reports by Savage et al. (1985, 1986, 1987). These studies examined incorporating various ingredients into the diets fed to turkeys. The meat produced then was evaluated for flavor and other sensory characteristics. In each of these studies, defrosted turkey halves were oven-roasted at 177°C until an internal breast temperature of 80°C was reached. Flavor, among other attributes, was evaluated using a 5-point category scale. Incorporation of live yeast culture (1985), yellow peas (1986) and triticale (1987) into turkey rations all resulted in no difference ($P > .05$) in flavor quality.

These six studies illustrate how sensory analysis techniques vary. When the same authors used the same technique, as in the Larmond et al. (1983) and Salmon et al. (1988) studies, a comparison among studies could be drawn. Similarly, the studies by Savage et al. (1985, 1986, 1987) allow comparison within studies. However, to attempt an among-studies comparison of these five papers becomes more difficult. Although they all used oven roasting, different oven temperatures (163 and 177°C) and end-points (85°C, 80°C) were employed. Different sensory scales were used. Possibly, more consistency in the techniques would permit more reliable comparisons.

Chicken. Of the 16 papers since 1979 reporting the effects of a dietary change on chicken flavor, 10 studies investigated rapeseed meal, now commonly called canola meal (Steedman et al., 1979a,b; Griffiths et al., 1980; Hawrysh et al., 1980a,b,c, 1982; Salmon et al., 1981, 1984; Kiiskinen, 1983). Both high- and low-glucosinolate canola meals were studied, as well as the addition of rapeseed meal screenings (RSSM), herring meal, D-L methionine and choline chloride. The single factors reported in the other six papers included formic acid to eliminate pathogenic microorganisms (Basker and Klinger, 1979), En-hance®, a commercial flavor-enhancing feed additive (Wabeck and Heath, 1982), garlic as a contaminant of wheat (Heath et al., 1983) narasin, an antibiotic that is an effective anticoccidial agent (Rhorer et al., 1984), shrimp by-catch composed mainly of *Saurida undosquamis* (brush tooth lizard fish) and *caranx kalla* (herring) not suitable for human consumption (Ilian et al., 1985), and dried poultry droppings (Ologhobo, 1988).

Canola (Rapeseed) Meal Studies. Because canola meal is the largest single feed documented in the last 10 yr, it will be considered as a separate entity. Further, this will serve as an example of the merit of a planned sensory analysis approach. The primary researchers were Steedman et al. (1979a) and Hawrysh et al. (1980a,b,c, 1982); they authored 6 of the 10 papers and laid a foundation onto which other researchers could build using similar approaches. The four trained laboratory panel studies performed by Hawrysh et al. (1980a,c, 1982) and Steedman et al. (1979a) revealed essentially identical sensory techniques. The technique consisted of a 46-h thaw at 2°C followed by oven roasting at 163°C to an internal breast and thigh temperature of 88 to 89°C and subsequent cooling to 50°C. The excised cooked muscles (breast and thigh) were wrapped in saran and foil and refrigerated (2°C) for 18 h (Hawrysh et al., 1980a,c; Steedman et al., 1979a), with the exception of the 1982 study, which had a 2-h refrigerator storage time (Hawrysh et al., 1982). Through consistency in their sensory approaches, these two researchers could plan each successive study based on the knowledge gained in their previous studies. The result was a series of papers logically investigating canola meal (low- and high-glucosinolate) and additives.

Both Steedman et al. (1979a) and Hawrysh et al. (1980c) concluded that the addition of herring meal (5%), D-L methionine (.1%) and choline chloride (.05%) to either low- or high-glucosinolate rapeseed meal ration resulted in "fishy," "unpleasant," "rancid," or "stale" odors and flavors. The "fishy" taint was attributed by Hawrysh et al. (1980a), using Halloran (1972) as a reference, to the addition of D-L methionine and choline chloride (added methyl groups), which led to the formation of TMA (trimethylamine), a protein degradation product that is one of the components responsible for fish odor. Salmon et al. (1981), using the same sensory technique but an end-point of 85°C rather than 88 to 89°C, found that canola meal (28% starter diet, 12% finisher diet) resulted in an increased frequency of off-flavors and a decrease ($P < .05$) in chicken flavor. In this study, he questioned whether the off-flavor may be a result of the methionine and choline rather than the canola meal. Hawrysh et al. (1982) later demonstrated that dietary supplements of methionine and choline had no effect ($P > .05$) on chicken flavor quality. Salmon et al. (1984) concluded that the frequency of off-flavors increased ($P < .05$) when broilers were fed diets containing 5% herring fishmeal together with added choline (.1%) and methionine (.05%).

Several nutritionally superior, low-glucosinolate rapeseed cultivars were introduced around 1980. This led to several studies of high- versus low-glucosinolate canola meal. Hawrysh et al. (1980c) found that feeding 20% Tower, a low-glucosinolate cultivar, in diets to broiler chickens did not ($P > .05$) affect the eating quality of the cooked chicken meat. However, in another study she concluded that including 10% low-glucosinolate RSSM lowered ($P < .05$) the score for odor and flavor relative to chickens fed soybean meal (SBM) diets (Hawrysh et al., 1980a). At levels of 2.5 and 5%, scores of birds were not different ($P > .05$) between RSSM and SBM diets.

Griffiths et al. (1980), investigating a high-glucosinolate rapeseed meal at 10% of the diet found no effect ($P > .05$) on chicken flavor. Their sensory technique consisted of an overnight thaw (7°C) followed by roasting in foil at 195°C for 45 min (breast) or 60 min (thigh). Four sample pairs were presented for evaluation by using a 4-point scale for rating flavor differences. Although cooking time was standardized, there was no indication whether oven-ready weights were identical. If weights were not identical, different end-point temperatures after a 45-min or 60-min roast could negate any apparent treatment differences.

Kiiskinen (1983) concurred with Hawrysh et al. (1980c) that feeding up to 15 to 20% low-glucosinolate RSM had no adverse effect ($P > .05$) on the flavor of the meat. However, to qualify this result, the methodology reported was as follows: "The thawed carcasses were

TABLE 1. TOTAL NUMBER OF RESPONSES TO THE ATTRIBUTES OF UNPLEASANT, FISHY AND OILY FLAVOR[ab]

	Rapeseed meal level, %		
Attribute	0	16	22
Unpleasant flavor	8	0	3
Fishy flavor	2	5	1
Oily flavor	3	1	3
Total	13	6	7

[a]Total number of observations for each attribute and rapeseed level was 28.

[b]Adapted from Kiiskinen (1983).

covered with aluminum foil and cooked in an electric oven (200°C for 1.5h) without any spices. A panel of seven people at the Institute independently tasted for strange and unpleasant flavors in breast and thigh meat". Again, oven-ready weight is not addressed and, thus, all treatments were not at the same end-point temperature upon completion of cooking. Further, among 28 observations for the control, 13 had observations of "off" flavors (Table 1). This raises a concern about the control sample because a control sample should have no off-flavors.

In the remaining studies the following conclusions were drawn.

Formic Acid. Chicken feed treated with 1.2% of formic acid had no adverse affects ($P > .05$) on meat flavor (Basker and Klinger, 1979). The sensory method employed was a consumer evaluation of chicken prepared by an Orthodox Jewish practice. A mixture of qualitative and quantitative scales were used. Thus, the conclusions drawn were limited by the conditions of the study.

En-hance. Wabeck and Heath (1982) concluded that the flavor and aroma of broiler products were improved through the addition of an additive, En-hance®, to the finisher or "withdrawal feed" (Table 2). However, the table presented indicated no difference ($P > .05$) in flavor or aroma.

Garlic-Contaminated Wheat. Heath et al. (1983) stated that garlic can be fed in broiler rations at the rate of 33 bulblets/kg of wheat and not cause differences ($P > .05$) in the flavor of broiler meat. Their data further suggests that the diet could contain up to 100 bulblets/kg of wheat without affecting the flavor.

Narasin. In a paper investigating the effects of narasin (Rhorer et al., 1984) on broiler flavor, no off-flavors ($P > .05$) were imparted to the broiler meat. Although the study had a very thorough description of the triangle test, the authors explained that due to a "position effect" they moved the samples clockwise! This practice is frowned upon by sensory analysts. It is disconcerting to read a detailed explanation of an inappropriate execution of a fairly simple difference test. Normally, when publishing sensory analysis data, it is sufficient to state the type of test used and it is assumed that the researcher knows and understands how to properly conduct the test. However, the preceding example leads one to question how often tests are conducted improperly.

Shrimp By-Catch. Ilian et al. (1985) concluded that there was no difference ($P > .05$) in the flavor of chicken meat when shrimp by-catch was added to the diet at levels of 2.5, 5.0 and 7.5% (Table 3). Yet, as can be seen clearly in their data, they could have stated that flavor was superior ($P < .05$) for the 10% shrimp by-catch diet.

TABLE 2. SENSORY PANEL AVERAGE SCORES FOR ROASTED CHICKEN COOKED COVERED AND UNCOVERED FOR LAST 10 MINUTES FROM BROILERS FED EN-HANCE® FEED ADDITIVE FOR 10 DAYS PRIOR TO SLAUGHTER[a]

	En-hance			
Attribute	Control	5 g/kg	15 g/kg	25 g/kg
Uncovered				
Natural flavor light	6.0[b]	6.0	6.0	6.1
Dark	6.2	6.9	5.7	6.3
Covered				
Natural flavor light	4.8	5.6	4.5	3.6
Dark	4.5	6.0	5.0	5.8

[a]From Wabeck and Heath (1982).

[b]No variance data were provided in the original paper.

TABLE 3. SENSORY PANEL AVERAGE FLAVOR SCORES FOR POULTRY FED SHRIMP BY-CATCH[a]

% Shrimp by-catch	Flavor score[bc]
2.5	4.81[e]
5.0	5.25[ef]
7.5	5.45[ef]
10.0	6.00[f]

[a]From Ilian et al. (1985).

[b]Scored from 1–9; 1 = extremely inferior, 9 = extremely superior to control.

[c]Means followed by similar letters were not different ($P > .05$; 12 obs/mean).

Case Example

Over the past 2 yr, our Food Research Centre has been involved in a collaborative study with researchers at the Kentville, N. S., Agriculture Canada Research Station investigating the effects of diets supplemented with fishmeal on chicken flavor.

Two replicate studies were conducted to evaluate the effect of fishmeal supplementation of chicken diets at levels of 0, 4, 8 and 12% on the flavor and texture of the chicken meat. The sensory analysis experimental approach was identical in all respects except one. One of the replicates was cooked and evaluated directly after cooking; the other replicate was cooked, sampled for sensory analysis and placed in 4°C storage overnight.

Same Day Testing: Part 1

Part 1 was referred to as "same day" testing. Differences due to diet were seen in the parameters of chicken flavor ($P = .034$) and fish off-flavor ($P < .01$; Table 4). Inexplicably, the 4% fishmeal level resulted in a higher chicken flavor score and the lowest score for fish off-flavor. The results of the other three treatments were not different from each other. Therefore, practicality and common sense led to the conclusion that no significant differences were observed when fishmeal was added to the diets at up to 12% because the only difference inexplicably was seen at the 4% level, and not at the 8 and 12% levels.

Next Day Testing: Part 2

Part 2 results were based on evaluating the samples the next day following storage (4°C) for 24 h. The results showed a ($P < .001$) linear effect due to diet. The conclusion drawn was that "it was quite clear in this study that fishmeal supplementation does affect the flavor characteristics of chicken meat. A decrease in chicken flavor coupled with an increase in fish off-flavor results in a fish flavored chicken." Presumably, a fish flavor is not desired. Therefore, based on the results of this study, supplementation of chicken diets with fishmeal any higher than 4% would result in an undesirable chicken product.

This demonstrates how altering the sensory analysis protocol can change the conclusions that are drawn.

It is essential that each collaborator within a project understand the product under investigation and the end uses as well as the overall project objectives. In this case example, if the chicken is used immediately following cooking, there is no concern with "leftovers," and the Part 1 approach is sufficient. However, if chicken is stored in the refrigerator overnight, the information gained and conclusion drawn in Part 2 is essential to further understanding

TABLE 4. SENSORY MEANS[a] AND THEIR STANDARD ERRORS FOR VARIOUS LEVELS OF FISHMEAL AS DESCRIBED IN THE CASE EXAMPLE

		Level of fishmeal, %					
Attribute	Part	0	4	8	12	SEM	Significance
Chicken flavor	1	6.8	8.2	6.6	6.3	.45	*
	2	9.8	9.3	5.2	4.4	.43	***
Fish off-flavor	1	2.2	.9	2.4	3.0	.39	**
	2	.6	1.1	5.3	6.7	.28	***

[a]Means based on Part 1 had n = 59 and 24 df; Part 2 had n = 36 and 15 df.

*$P < .05$.

**$P < .01$.

***$P < .001$.

the product.

In summary, over the past 10 yr the effects of such feedstuffs as canola meal, fishmeal, vitamin E, live yeast culture, formic acid and others on poultry meat flavor have been investigated. More documentation is available for canola meal than for these other additives.

As with any other scientific discipline, sensory analysis requires a well-conceived approach. Overall project objectives, sensory objectives, test methods, sample preparation and presentation, experimental design, panelist training, statistical analysis and interpretation of results all must be addressed before commencing a sensory analysis test. Like any other scientific analysis, sensory analysis requires adequate thought and planning if it is to be conducted and interpreted correctly.

Implications

Considerable thought should be given to planning of sensory analysis. Lack of planning is tantamount to failing to establish a protocol for a chemical or proximate analysis. If the protocol developed is not based on accepted methodologies or sound scientific techniques, the results may be invalid due to methodology. Furthermore, the accuracy, validity and reliability of the data likely would be criticized. Similarly, if a sensory analysis approach is not based on accepted sensory principles and techniques, the value of the results is open to dispute.

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