THE INFLUENCE OF QUALITY OF SELECTED WINES ON THE SENSORY CHARACTERISTICS OF LOBSTER BISQUE, POACHED BREAST OF CHICKEN, AND COQ AU VIN

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Food Science and Human Nutrition

1979

ABSTRACT

THE INFLUENCE OF QUALITY OF SELECTED WINES ON THE SENSORY CHARACTERISTICS OF LOBSTER BISQUE, POACHED BREAST OF CHICKEN, AND COQ AU VIN

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The influence of wine quality upon the sensory characteristics of foods was studied. The foods and wines used in the study were lobster bisque flavored with dry sherries, chicken breasts poached in white wines, and chicken thighs braised in red wines. Sauces were also prepared for each of the chicken products. Lobster bisque was flavored with a California dry sherry, a cooking sherry, an imported fino-type sherry (Spanish), and evaluated by a consumer panel. The breasts and thighs were prepared with a standard, inexpensive "jug" type of wine, a cooking wine, a premium wine and a control which was prepared with chicken stock. Evaluation was done over six replicate sessions by a trained sensory panel.

Analysis of variance was used on the product's mean scores and multiple-range tests were used to analyze which means were different when statistical variances were established. The wines were used for three different purposes in the tests. The lobster bisque used sherry as a flavoring

which was added following the cooking of the product, the poached breast utilized wine as a heat transfer medium as well as a substrate for the sauce while the thigh preparation called for the wine to be a basic ingredient as well as providing the liquid required for the braising process.

The consumer panel found the bisques flavored with the California and cooking sherries preferable to the one flavored with the imported sherry. There was no statistical difference between the California and cooking sherries although the California wine-flavored bisque was ranked ahead of the one flavored with the cooking wine by all population segments. There do not appear to be any differences between domestic sherries made for consumption and those wines prepared specifically for cooking with regard to their effect upon the sensory characteristics of lobster bisque; imported fino-type Spanish sherries may have a negative effect.

Chicken breasts and thighs were evaluated for aroma, tenderness, juiciness, flavor, and color, whereas the sauces were scored for aroma, flavor and color. All evaluations were done on a thirteen-point hedonic scale with thirteen being the highest. Objective evaluations of the tenderness and juiciness quality parameters were done with Carver Press and Kramer Shear Press measurements. Analysis of the results from the breasts and their sauces showed that not only did it not matter which wine was used, but neither did it matter

whether wine or stock was used as the poaching liquid indicating that different white wines may not be able to be differentiated as a poaching liquid and that using wine instead of stock results in cost disadvantages rather than quality improvements.

Data from the braised thighs were similar in that the three wine-braised products showed no scoring differences among them. Unlike the breasts, comparison between wine-braised and stock-braised thighs indicated significant preference for the products prepared in wine, implying that wine may be preferable to stock as a braising liquid. Evaluation of the thigh sauces indicated that red wine quality has little, if any, effect upon sensory characteristics of the sauces.

The study showed that while wine quality has negligible influence upon food sensory quality, there are substantial differences in the costs of using various wines.

ACKNOWLEDGEMENTS

To Dr. Mary Ellen Zabik for her assistance, guidance, and patience, not only in the preparation of this dissertation, but throughout the entire graduate program as well.

To Dr. Charles M. Stine and Professor A. L. Rippen for their support as members of the Guidance Committee.

To Dr. Lewis J. Minor, whose support, encouragement, and friendship over the years have meant a great deal to the author.

To Dr. Robert L. Blomstrom who, through his financial support, encouragement, and interest, made it possible for the author to change careers.

To the students who participated in the sensory evaluations and whose enthusiasm helped in making the study a success.

To Chef Louis Szathmary, who graciously allowed the author to use his private library.

Finally, to my wife, Kathleen, without whom this dissertation and degree, along with a great deal more, would not have been possible.

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INTRODUCTION

The use of wines in cookery is a common practice in many cultures. Alcoholic beverages in general, and wines in particular, have many potential functions in cookery. They can, for example, function as a liquid by partial or complete replacement of water, thinning other fluids or adding moisture to a product and thus acting as a diluent. Since they contain alcohols and acids, they can dissolve food substances which are not readily water soluble. Foods are marinated both for flavor enhancement, (or alteration), and for the purpose of increasing tenderness. Wines are widely used for both of these purposes. Wines can also be used strictly for their value as a flavor enhancer.

Wine is therefore a common ingredient in cooking, (and an essential one in French Cuisine). Almost without exception, the great chefs and recognized food authorities down through the years have strongly recommended against the use of wines which would ordinarily be regarded as inferior. The literature particularly recommends against the use of wines formulated specifically for cooking. The claims of the various companies which manufacture "cooking" wines indicate that not only are they acceptable, but are preferable. These companies make statements to the effect that while some

wines are great for drinking, they are too delicate for cooking, that cooking wines are selected for rich, robust flavors which will not cook out, and that cooking wines do not vary from bottle to bottle.

These claims and counter-claims serve only to obscure rather than clarify the subject of wine cookery. They can be classified as opinions for they are not supported by any substantive research. Neither is there any indication as to whether these opinions have ever been properly tested or what their factual basis is. The rationale supporting the belief in the importance of wine quality in cookery is that, in food preparation, the quality of the base materials has a significant effect upon the nature of the finished product. Thus, it follows that any base or raw material used, whether an egg, onion, stalk of celery, or wine, should be of the finest quality obtainable.

Another factor to consider in cookery quality, however, is the suitability factor. It is not ingredient quality per se which determines the finished quality but rather suitability of a particular ingredient for a specific usage. A tomato which is to be stuffed for a luncheon plate must be firm, have a bright color, be free of blemishes, and be of uniform size and shape. When selecting tomatoes to be used in a sauce, the criteria change to juiciness, strength of color, flavor, and acidity. Size, external color, firmness, shape,

and consistency of shape have nothing to do with its suitability for making a sauce. All food preparation ingredients are subject to this test of suitability and it supercedes the test of quality alone. This appears to be the basis underlying the position of the proponents of "cooking" wines.

The food-service industry has become one of the most significant economic forces in the United States. In an era of increasing concern over unemployment, the food-service industry is the nation's largest employer, providing jobs for over four million persons. Industry sales of food and beverage exceed $100 billion and there are estimated to be well over 550,000 separate and distinct food-service outlets in the United States.

To realize the potential importance of wines in cookery, it is first necessary to have some knowledge of the financial and marketing structure of the industry. Historically, the largest single cost to an operator was the product cost, the cost of the specific foods and beverages sold. The situation is no different today. The most recent study done by the National Restaurant Association in conjunction with the accounting firm of Laventhol and Horwath (1978) indicates that 31.2 percent of each total sales dollar was spent upon food alone and that 41.2 percent of each food sales dollar (excluding beverage sales and other income) was used for food.

The next highest expense, cost of labor, was substantially behind with a percentage cost of 30.6. Cost of product thus remains the most significant source of expense to the industry.

From a marketing viewpoint, there is increasing pressure upon food-service operators to be innovative and creative. Success seems to be achieved by those who can best integrate structural design and menu concepts into a modern, fresh approach. Much attention is of course paid to food development. Another aspect to be considered is America's belated (relative to continental Europe) emergence as a wine-consuming society.

These factors show a rapidly growing interest in, and knowledge of, wine, along with an increasing necessity to merchandise food. It may well be that wine cookery will become more important in the United States than it ever has been. Coupling this with the sheer magnitude of the food purchase dollar, we can see that the question of which is the proper quality wine to use could be a significant economic decision. Cooking wines can be purchased for about $2.00-$2.50 per fifth. Table wines are sold for as low as $1.50 per fifth (the so-called "jug" wines), up to hundreds of dollars per bottle, although the majority will be in the range of $3.00 to $5.00. For anyone using appreciable amounts for cooking, there is a large range in the potential operating cost. If the proponents of "cooking" wines are correct, the

cost would be moderate. If those who insist upon "fine" quality wines are justified in their beliefs, the expense would be greatly increased. If it does not make any difference what quality wine is used, the potential expense would be moderate to quite low. Additionally, there exists a fourth possibility; that it does not matter whether wine is used at all, and this could obviously result in a reduction in the expected cost of food production

Appendices 6, 7 and 8 give cost comparisons among the various products prepared in the study. Although the total costs will vary as time passes, due to economic trends, the cost relationships as given should remain consistent. It can be seen that the inexpensive wines produce food products with the lowest costs and that "cooking" wines are nearly, but not quite, as low. The use of premium wines clearly increases the product cost rather substantially. In the case of lobster bisque, the increase (relative to the standard, or inexpensive, wine) is nearly 26 percent while with the chicken breast and thigh it is 25 and 37.5 percent respectively. The potential cost saving resulting from using stock rather than wine in the chicken products is 19 percent for the breasts and 18 percent for the thighs.

In order to formulate a hypothesis about the effects of wine quality on finished food quality, it is necessary to examine what happens to alcoholic beverages when heated. One

of the primary constituents of all alcoholic beverages is ethyl alcohol and, due to its relatively low boiling point, it simply evaporates at all cooking temperatures. All wines have color, even white wines, but it is most obvious in red and rose wines. Some red wines are very strongly colored and this could be expected to affect food products. When the color compounds in wine are heated they can be substantially altered and, in some cases, lost. Wines may be completely dry; that is, all the grape sugars have been totally fermented, but more often they have some sugars present. Sweetness is practically stable and can be retained, although with high sugar wines, such as cream sherry or port, admixture to a reducing sauce must be accompanied by care and constant supervision for burn-on (carmelization) occurs easily and frequently. The other main flavor constituents, in addition to sugars, are acids, some of which are volatile and hence lost. Some wines, such as sparkling wines and the so-called "crackling" or "frizzante" wines, along with beers, have carbon dioxide as an integral component and this evanesces with even slight heat. All aromatics are volatile and will vanish with temperature and time.

It seems reasonable, based upon the expected effects of heat on alcoholic beverages, that whatever differentiating components are present in "fine" wines would be lost or substantially altered by heating and cooking. The hypothesis

to be tested is that there is no difference in the perceived quality of foods prepared with various wines, even though the wines used may differ dramatically in their accepted quality standards.

REVIEW OF LITERATURE

Although there has been much written on the effects of wine quality upon food quality in food preparation, there has been little scientific inquiry into the subject, and most material is of a conjectural nature or opinion. One of the reasons for undertaking this study was that virtually all those associated with food preparation, either as working professionals or as writers, had very positive feelings but no one had ever tested it from a quantitative standpoint or, if they had, the documentation was either lacking or unavailable.

To research the subject, a number of scientific data bases were searched. They were: Food Science and Technology Abstracts, Chemical Abstracts, United Kingdom Food Science Abstracts, and Doctoral Dissertations. These yielded nothing in the area being tested but did provide information in related areas, such as wine components, effect of heat upon wine components, etc. The next step was to review food books, cook books, culinary texts, food science texts, popular food and wine journals, and wine books and texts. This was done utilizing the facilities of the Michigan State University Library, the Library of the School of Hotel Administration,

Cornell University (including their rare book collection), and the personal library of Chef Louis Szathmary of the Bakery Restaurant in Chicago, Illinois. Finally, the Readers Guide to Periodical Literature was reviewed. The references which are from actual research papers will be noted unless it is clear that they do refer to research and not conjecture, opinion, personal feelings, or bias.

History of Wine

Wine probably dates back to prehistoric times when a cave dweller came across some crushed grapes he had forgotten. During his absence, fermentation occurred due to the presence of yeasts on the grape skins and wine was the result.

Archaeologists maintain that grape wine was made 8,000 years ago, and it has been suggested that honey was fermented even earlier (Johnson, 1971). Honey and water fermented and flavored with herbs is called mead. In addition to honey, date and palm wine may have preceded grape wine. The Bible mentions wine frequently, in both the Old and New Testaments (Lichine, 1974).

Wild grape vines were probably first cultivated in the Caucasus where the wild vine flourished (Tannahill, 1973). By 3000 B.C. the vine had reached Mesopotamia and Egypt as well, where wine was used predominantly for temple

rituals. Wine does not appear to have been used as a popular drink in Egypt until the influence of Greece in the first millennium B.C., at which time private vineyards became common. The art of making wine reached Greece by 2000 B.C. and is believed to have come both from Egypt and the East. From about the fifth century until the latter part of the first century B.C., Greece and its islands were, to the Mediterranean world, the home of fine wines (Tannahill, 1973). Thus it is probable that Greece simply re-exported to secular Egypt the knowledge that they had earlier imported from priestly Egypt (Tannahill, 1973). The best wines of the Greek golden age were probably those of the islands of Lesbos and Chios, which were imported by the wealthy of many countries even though most produced their own vin ordinaire. The great vintages appear to have been quite sweet and Lichine (1967) suggested that the most famous wine of antiquity, the Pramnian mentioned often by Homer, may have been as rich as Tokaji. This is supported by the fact that with both the Greeks and Romans, as with the Egyptians before them, the custom was to dilute the wines with water prior to drinking and the finer vintages were often kept until they were as thick and sticky as honey (Tannahill, 1973).

Aging of wines was first practiced in Greece where they were kept in clay cylinders called amphorae, which were used if the wines were intended for export. If it was to be

consumed locally, it was filtered into goatskins or pigskins following fermentation in vats smeared inside and out with resin (Tannahill, 1973). The Greeks, to this day, have a predeliction for resinated wines which are said to be compatible with some types of Greek food. In spite of, or perhaps because of these treatments, the wines did not keep well unless special mixtures were added, since fermentation was not a scientifically-controlled process, being more of an uncertain art at that time. Each region had its own specific formula of additives. One, for example, consisted of a brew of herbs and spices mixed with condensed sea water and matured a number of years. A later Roman recipe called for the addition of liquid resin blended with vine ash to the grape must prior to fermentation (Tannahill, 1973). The Romans often matured their filled wine jars in lofts where wood was seasoned and meat was dried and cured. Although a reasonable smoking process was thought to improve wine (Lichine, 1967), the more cultivated Romans were harsh in their criticism of French vintners who over-smoked their wines in order to increase their apparent age (Hyams, 1965). Another additive often used by Roman wine merchants was a preservative syrup prepared by boiling in lead-lined pots. This contributed to the suggestion of the American sociologist, Colum Gilfillan, that the Roman aristocracy suffered acutely from lead poisoning (Tannahill, 1973).

Since the Grecian amphorae were non-porous and thus air-tight, they had the capability of aging and holding wine under somewhat modern conditions even though the wines themselves were vastly different and inferior to the modern ones. This knowledge of air-tight packaging must have been lost or forgotten since some 1,500 years were to pass before the bottle and cork came into usage.

Another Roman custom, made necessary because of the porosity of their amphorae, was to coat the insides with tar, a process called pitching. This certainly prevented air from entering the vessel but it must have introduced many foreign substances and compounds into the wines (Bell, 1976).

Following the introduction of the first of the great Italian vintages, the Opimian, in 121 B.C., Greek wines went out of international fashion (Hyams, 1965) and in the following century that wine, plus the Falernian and other Italian wines, offered very stiff competition for Greece. The Italian vineyards could produce over 2,000 U.S. gallons per acre (Derry and Williams, 1960) which was much more than the Greek vineyards could harvest. The rise of Rome, as a world power, contributed as well to the expansion of the taste for Italian wines and the vine itself was carried to many new lands. Near the year 1000 B.C., the vine was in Sicily and North Africa and during the next 500 years reached Spain, Portugal,

Southern France and probably Southern Russia as well. With the advance of the Roman Empire, the vine finally spread into Northern Europe and Britain. The following dates are regarded by Johnson (1971) as approximations of the introduction of vines in various modern viticultural areas: Marseille (France) 600 B.C., Bordeaux (France) 50 A.D., Rhone (France) 50 A.D., Burgundy (France) 150 A.D., Loire (France) 250 A.D., Rhein/Mosel (Germany) 300 A.D., Champagne (France) 350 A.D., Alsace (France) 800 A.D. After the fall of the Roman Empire, the church was the prime mover in viticulture and, due to the need for wine for both sacrament and sustenance, the church, through the early middle ages, was in the vanguard of wine producing knowledge and developed modern methods. At the same time this was happening in Europe, the predominancy of the Moslem religion in the Middle-East caused the cessation of alcoholic beverage consumption in that part of the world. The disappearance of the knowledge of the Grecian amphorae meant that, during these years, wines were consumed very young and were probably acrid and crude by our standards and most likely only made palatable by the addition of spices and honey.

The Portuguese made two discoveries during the 1700's which were instrumental in ushering in the modern era of wine. They were the first to fortify wines and to ship corked bottles. Both of these milestones came about because of market pressures. The wine merchants of Oporto had a handicap

insofar as competition with the wines of Lisbon were concerned. The problem was that the Oporto wines were very dry and the demand was for sweet wines. Wines from Oporto had no residual sweetness, even though the grapes were abundant with sugar when picked, for the hot climate in the Duoro Valley resulted in a vigorous fermentation which consumed all the natural sugar. Fortification of the wine with alcohol (brandy) during fermentation stopped the yeast activity and the wine retained considerable sugar. This, however, gave rise to another problem; the wines were harsh and unpalatable and needed maturing. It was found that barrel aging alone was insufficient so an equivalent of the ancient amphora had to be developed. This was the corked bottle and occurred about 1780.

By the late 1800's, the vine had attained great economic importance in Europe. In Italy, for example, it was estimated that approximately 80 percent of the population relied, at least in part, on wine for a living (Johnson, 1971). During this time, the greatest single disaster in the history of viticulture occurred. A root-sucking vine louse, Phylloxera vastatrix, was introduced into Europe from America. The European wine variety, Vitis vinifera, had no acquired immunity to this insect as did the native American vine, Vitis labrusca, and the result was nearly the complete destruction of the vineyards. Virtually every vine in Europe

was destroyed or had to be uprooted. The solution, which nearly came too late, was to graft the Vinifera vines onto the Labrusca rootstock. Today, except for a few vineyard areas never exposed to Phylloxera either because of their isolation (parts of Chile) or relative newness as a wine region (Monterey Valley, California), all Vinifera vines, whether they be in France, Germany, Italy, California, or wherever, are grafted.

History, Development and Advice/Instructions on Cooking with Wine

Much of the material noted here is of a popular or an opinion nature. Any references from research papers will be identified as such.

Wine in cookery, as Raymond Oliver (1967) pointed out, is a very old custom. The wines of ancient Greece, Turkey, Crete--infact from all the Mediterranean basin--were used in cookery as yellow wine was in Chinese recipes. Although there was no contact between Oriental and Western civilizations during Antiquity, there were analogies in the use of wine in cookery. Wine was added to food to improve it, an idea which has been current for 5,000 years.

Wine, in the beginning, was excluded as the starting point and only entered into the composition of a dish as an ingredient. Coq-au-vin, as it is today, was unimaginable a

century ago and it was only at the beginning of the nineteenth century that wine, in cookery, acquired this importance. Oliver (1967) attributed this change to the fact that wine was popularized at the same time that gastronomy became democratic.

In this country, whatever strides had been made in cooking with wines and other alcoholic beverages must have been set back a great deal by Prohibition (Taylor, 1963), for Phillips (1934) remarked that her long-time family cook had only recently revealed to her some of her choicest recipes and that Repeal was the reason. During Prohibition, the only alcoholic ingredient stocked in the kitchen larder was cooking sherry, highly salted.

The question of alcohol always appears to have been controversial. In 1905, an anonymous writer had this to say in the June issue of Current Literature (Anon., 1905):

> In its relation to the human organism the food value of alcohol is only negative, and may well be ignored; and by restricting its use entirely to remedial purposes no loss to the race would be entailed, and incalculable benefit would accrue.

There is no shortage of information on how to cook with wines and what kind of wine to use, but the vast majority of it appears to fall under the category of opinion. Many writers have very strong feelings about such matters but few appear to have ever subjected the question to any evaluation mechanism beyond their own palate.

Quality of Wine

Field (1965) said that there are no such things as cooking wines, only wines which are fit or not fit to drink. Beard (1959) was of the opinion that in cooking, the better the wine, the better the dish. An anonymous author, in an article in House and Garden (Anon., 1945), alleged that only a wine that is good enough to drink is a worthy addition to culinary flavor.

Discussing the place of wine in adding variety to diets restricted by rationing during World War II, Holt (1943) said that no wine which is unfit to drink should come to the table concealed in a casserole and that there is no such thing as "cooking wine." What there is, is wine, and it is a matter of taste whether it is consumed from a glass or in a stew. An interesting opinion was offered by the New York Times (Anon., 1942). Fine vintage wines are wasted in food, unless perhaps you are entertaining a member of Les Amis d'Escoffier or someone of similarly keen perceptions. This seemingly implied that the quality of very fine wines can be transferred to foods, but only sophisticated diners would be able to appreciate the result. According to Ozias (1934), it is obvious that wine used in cooking need not be a rare and costly one and that for many dishes a wine that is not too delicate is preferred for it is the fruit flavors and the

acids in wine which make it such an invaluable aid to good cooking. Modestly priced wines were preferred by Bentley (1934), for a trifling amount adds flavor to many foods. Oliver (1967) had strong feelings on the quality of wine to use in cooking; one must choose the best and must, of course, avoid the mediocre. He said that his father thought that wine for cooking should be both young and strong, while the best jugged rabbit he himself had ever eaten was prepared with an entire bottle of 1945 Chateau Haut Brion and he attributed the quality of the dish to the quality of the wine.

One of the great writing chefs, Louis Diat (1961) admonished never to use in cooking a wine you would not drink, while Rietz and Wanderstock (1965) found that the use of high priced wines for cookery is not justified since differences are not perceived. Guillaume (1978) felt that expensive wines can be justified on the basis of increased quality in the finished dish, but perhaps not from an economic standpoint although she also said it is important to choose really good wine, otherwise the flavor of the dish may be spoiled.

The Womans Day Encyclopedia of Cookery (1966) recommended the use of dry wine of good quality (a wine which you would like to drink). Adams (1971) wrote that the first qualification of a wine used for cooking is that it should be palatable enough to drink; nothing else can be considered.

Roberts and Easton (1978) recommended to always use good drinkable wines for cooking as the process, by reduction, brings out the best, or worst, in whatever you use. In one of the classic books on French cookery, Child, et al. (1970) said any wine used in cooking must be a good one and, lacking a good wine, it is far better to omit it, a view which Viron (1972) subscribed to as well. The Robottis (1972), Grossman and Lembeck (1977), Read (1978), Allen (1958), Hazelton (1961), Lucas (1974), Beard (1949) Caruba (1963), all said that wines of good quality must be used. Some of the phrases used were: wine must be good, for a poor wine will give poor results; the better the wine the better the dish; when cooked the alcoholic content is dispersed and the basic flavor alone remains; a wine whose quality is deemed inferior to the table cannot be used successfully for cooking purposes; all cooking should be done with good wine. Field (1965) said that although cooking a poor wine with food did not camouflage the wines imperfections, but instead intensified them through reduction and concentration, it did not necessarily mean cooking with a great wine. In fact, the ephemeral bouquet of a rare vintage wine will vanish irretrievably at the first touch of heat. A wine to be cooked should have fullness of body and a decided flavor. Along the same line, de Groot (1966) wrote that a wine which is too cheap to drink is too cheap for cooking, yet obviously it would be a waste to use

a great wine where the delicate subtleties that make it great would be lost in the cooking. Diat (1951), in discussing the preparation of sauces, acknowledged that the kind of wine to use is puzzling to people and gave two requisites for a proper wine to cook with. The first is that it be a dry wine and the second that it be a good one for a good wine sauce can never be made from a poor wine. It may not have to be a vintage wine and it can even be inexpensive, but it can never be a wine you would not want to drink from a glass. How good it should be depends upon usage. If it is to be reduced to nearly nothing in the pan with shallots, it can be an inexpensive one; if the recipe calls for reduction by half, the wine must be better; and if it is to be added at the end of cooking, as is often done with Sherry and Madiera, it should be a very good one. In an undated book (located in the library of the School of Hotel Administration of Cornell University), Manoha stated that while the "great names" are, of course, reserved for drinking, the notion that cooking resorts to inferior grades must be dispelled for the class of the wine is reflected in the sauce. Gourmets will carefully collect unfinished bottles after a meal and use the remaining contents in their next day's cooking. Hatch (1941) found that the very qualities which make wines expensive, delicate bouquets and flavors, are usually completely lost at the first touch of heat and, therefore, the first

lesson of wine cookery is that the most expensive wines are not, by any means, always the most desirable. Greyton Taylor (1963), of the famous Taylor wine family of New York, said that wine is like all other ingredients: the better the wine, the better the dish; therefore, any wine which isn't good for drinking isn't good for cooking.

The importance of quality is also emphasized by Allen (1934) who urged the use only of wines or spirits of good quality, since there seemed to be a widespread idea that the wines, cordials, brandies or rums used in cookery can be of an inferior quality and still contribute the right flavor. The classic Joy of Cooking (Rombauer and Becker, 1964) advised that the wine used should be good enough to be drunk with relish for its own sake.

Better Homes and Gardens (Anon., 1969) felt that the wine used for cooking should be a good one, though not necessarily expensive because the wine's flavor is what is sought and, if it is poor to begin with, it can ruin even the best recipe. Therefore, one should select a quality wine with rich body and aroma that enhances the flavor of the food. Director (1948) pointed out that you don't need a special wine for cooking but should simply use some of the table wine you have selected for dinner.

Heating Wines: Recommendations on and Consequences of

The New York Times magazine (Anon., 1942) said the delicate flavor of wine is spoiled if the wine is boiled and it, therefore, should not go into the saucepan until the food is nearly cooked. According to Field (1965), when wine is subjected to heat, the alcohol at once begins to evaporate and leaves a raw, acrid liquid which must be fully cooked to be edible. He illustrated this by discussing two popular French dishes, Coq-au-vin (chicken in wine) and Boeuf Bourguignon (beef burgundy), and claimed that the beef dish is better because it takes considerably longer to cook stewing beef than it does a young chicken. As a consequence, the wine in the Boeuf Bourguignon is fully cooked while that in the Coq-au-vin is undercooked. The classic Coq-au-vin was made with an old cock and took at least two hours to make it edible, and by that time the wine would be fully cooked. To compensate for this, he recommended pre-cooking the wine, reducing it to half its original volume before cooking a young and tender chicken in it. Guillaume (1978), on the other hand, said to avoid <u>boiling</u> wine on high heat. She recommended simmering gently, if necessary for an entire night in the oven. She also recommended, if a wine is supposed to cook for hours, to choose one with a pronounced taste, evidently recognizing that flavor degradation takes

place. In agreement with the principle of avoiding high heat is Allen (1958), who felt that moderate or low heat should be used in cooking all foods flavored with wine. In the Readers Digest Secrets of Better Cooking (1973), we are told that wine should never be added to a dish just before serving but should simmer with the food or in the sauce while it is being cooked, for as it cooks, it reduces and becomes a flavoring extract. Wine added too late in the preparation will give a harsh quality to the dish. An exception to this rule is fortified wines which are chemically different and serve as flavoring and seasoning agents. They also recognize that heat may unfavorably alter the color pigments in red wine, and hence the color of a red-wine sauce is sometimes unattractive but can be improved by adding tomato paste, brown sauce, or meat gravy. Heaton (1950) did not find any difference between long or short heating or adding wine just before serving, for she felt that it depends upon the recipe. She did, however, caution that where color is important, wine be used only in those dishes where the wine is lightly blended. On the subject of sauces, Caruba (1963) cautioned that if a wine sauce is cooked too long, it loses its flavor.

Some master chefs believed that, for stews or other food requiring long cooking times, it is preferable to use American rather than French wines (Kirshman, 1969) the

reasoning being that French wines tend to disintegrate when subjected to heat for an extended period of time. Taylor (1963) advised, when boiling foods, adding the wine at the last possible moment to insure that the aroma and bouquet of the wine are not boiled away. Ida Bailey Allen (1934) also recommended the use of moderate or low heat in cooking all foods flavored with wine. Bentley (1934) said one-half cup of wine can glorify a meat or sauce, if cooked with the food for a considerable time at a low temperature, the latter point being of importance to all wine cookery.

"Cooking" Wines

One of the wines used in this study was a "cooking" wine; a wine especially formulated for cooking to which salt had been added. The literature has been particularly harsh in its judgement of such products. Don't use the so-called "cooking wines" you can purchase from your food supplier (Bell, 1976). They are not high quality wine products and they are too heavily salted. David (1962) said a glass extracted from a bottle of respectable table wine is likely to produce better results in the flavor of the finished dish than will some wine reserved especially for cooking. Kirshman (1969) felt that cooking wines are those that even the bottler and labeller have designated as being unfit to drink, although the implication is that they are alright to

eat. The entire idea of cooking wines, in fact, came about because the wines which were used in the kitchen were salted to prevent the cooks from drinking them rather than putting them in the food and to make a deliberate decision of using poor wine, in the hope that some magic would take place when it was poured into the pot, is not to be commended! Poor wine, which was not palatable to begin with, will unfortunately only taste worse as its flavor becomes more concentrated. Many super markets and delicatessens carry bottles labeled "cooking wine" (Sarvis and Thompson, 1973). Do not be tempted to buy them, as the so-called wine is not for drinking, and if wine is not fine enough to drink it is not fine enough to use as one ingredient among your other carefully chosen ingredients. Beard (1949), when asked the question "What is a good cooking sherry?", responded that he was not aware that there was any such thing. Holt (1943) informed us that there is no such thing as "cooking sherry" or "cooking claret." A dissenting opinion was offered by Worth (1978) who said that although there is an old adage which states, do not cook with a wine you would not drink, she was surprised by one brand of "cooking" wine. After carefully taste-testing dishes made with "cooking wines" and identical dishes made with table wines, she found the results, with both, to be excellent, perhaps because the "cooking" wines were extremely fruity and low in acidity,

qualities which do not make for a great wine, but which enhance the flavors of food and stand up to prolonged heating. She also stated that "cooking" wines have some advantages over table wines, among which are: economy, consistency from bottle to bottle and year to year, longer shelf life, and greater availability.

Utensils

Many writers cautioned, when using wine in cookery, against the indiscriminate use of cooking utensils. Platt (1936) informed us that, although there is nothing very complicated about cooking with any wine, one thing never to forget is that any food in which wine is to be used should be prepared or cooked in either enamel, porcelain, earthenware, or iron, or possibly spotlessly clean unlined copper, but never aluminum or tin, as discoloration of the food would take place and, in some rare instances, poisonous effects might be created. The recommendation of unlined copper is a surprising one since, when copper is exposed to food chemicals, including lactic acid, vinegar solutions, carbon dioxide, hydrogen sulfide, and sulfur dioxide encountered in cooking foods, corrosion results (Smith and Minor, 1974). The warning against aluminum, however, has been well documented (Paul and Palmer, 1972). Guillaume (1978) advised not to use iron or aluminum pans, nor unlined copper.

Copper lined with stainless steel is fine, as is porcelain, earthenware, overproof glass, enameled steel or iron, and stainless steel. Foods which have been cooked in wine should be stored in china or glass.

Substitutions

Readers Digest (1973) recommended, if you do not have any wine and a recipe calls for it, substitution of an equal quantity of apple juice, or one-half cup water with the juice of one lemon, for each cup of wine required. Many writers warned against using champagne for cooking purposes (Guillaume, 1978), but Sarvis and Thompson (1973) mentioned that when haute cuisine chefs insist on using champagne in a certain sauce, they want that unique champagne flavor, not the bubbles or the alcohol. In this regard Rietz and Wanderstock (1965) suggested that dry white wine with a small additive of brandy serves as well as champagne.

Other Recommendations on Wine Cookery

Herbs are compatible with wine and so are some condiments. With red wine, thyme, clove-studded onion, bay leaves, and rosemary are recommended. With dry white wine, use tarragon, oregano, shallots, or saffron (Guillaume, 1978). Bentley (1934) advised to always add eggs or cream after

the wine and food are smoking hot and, as a further precaution against curdling, cook over hot water.

When both wine and herbs are used in a dish, the final result will be better if an infusion or extract is made of both and then added to the food. This is accomplished by mixing the chosen herb, or herbs, with wine and simmering for ten minutes. Following this, butter and grated lemon rind are added and it is simmered for an additional five minutes (Readers Digest, 1973). Guillaume (1978) suggested adding a pinch of sugar to a few dishes cooked with wine, and gave Coq-au-vin as an example. The result will be a more mellow sauce.

Wine Components

The research literature is rich in this area and most references are of a scientific nature, either based upon research papers or conveying information supported by much research over the years.

Water

The major component of wine is water, the amount of which varies from approximately 70 to 90 percent by volume. Pure water has no color, odor, or taste and wine only has sensory meaning in the deviation from pure water caused by the presence of other components. Thus, according to Amerine

and Roessler (1976), perception of wine is a complex of sensory responses that deviate, in certain ways and within certain ranges, from those associated with water.

Alcohols

Ethyl Alcohol--The second most important component of wine is ethyl alcohol which, in addition to its ability to protect against spoilage, is very important to the sensory quality of wine as it is an excellent solvent for odorous materials and has a slight sweet taste (Amerine, et al., 1972). It also moderates the taste of acids. Amerine and Roessler (1976) reported that, if a wine is carefully dealcoholized and then brought back to the original volume with water, it will taste much more acidulous and unbalanced than the original wine. They also stated that alcohol content controls the viscosity (body) of the wine, which in turn affects the degree of acid taste. The source of ethyl alcohol is primarily from fermentation of levulose and dextrose (normally present in the mature grape in a 1:1 ratio), although a little may result from hydrolysis of glucosides during prolonged aging (Amerine, et al., 1972). Commercial table wines have 9-14 percent ethyl alcohol by volume and dessert wines range from 14-21 percent. Wines with less than 9 percent are not very stable, travel poorly, and spoil easily (Bell, 1976) although there are some notable exceptions such as wines from

the Mosel/Saar/Ruwer region of West Germany, which are among the lightest and most delicate natural wines in the world. In terms of wine production, most wines with more than 14 percent ethanol have been fortified, i.e., have had wine spirits (brandy) added.

Methyl Alcohol--Methyl alcohol does not appear to be produced by alcoholic fermentation but is derived primarily from hydrolysis of naturally-occurring pectins (Amerine, et al., 1972). There are usually greater amounts in red wines as opposed to whites and roses since the reds are fermented on the skins. Amerine, et al. (1972) indicated that the sensory importance of methyl alcohol has not been studied, although many methyl esters are very fruity in odor.

Higher Alcohols--A number of aliphatic alcohols with more than two carbon atoms exist in musts or are produced during alcoholic fermentation, and are found in wines. According to Peynaud and Guimberteau (1956), about 90 percent or more of the higher alcohols are 3-methyl-1-butanol (isoamyl alcohol), 2-methyl-1-butanol (active amyl alcohol), and 2-methyl-1-propanol (isobutyl alcohol). In red wines, about one-fourth of the higher alcohols was isobutyl, and in whites one-third. All of these, as noted by Amerine and Roessler (1976), have more or less of the fusel oil odor, which at high concentrations are a negative quality factor but at low concentrations may add desirable complexity to the odor. Amerine, et al.

(1972) stated that the port industry of Portugal appears to accept and appreciate the fusel oil odor, even at rather high concentrations, although they feel this may be more a matter of acquired taste than a real preference. High concentrations of fusel oil odor in dessert wines are considered undesirable in the United States. Filipello (1951) found a negative correlation between higher alcohol content and sensory quality.

Glycerol

Most enologists consider that glycerol, a by-product of alcoholic fermentation, is of considerable sensory importance because of its sweet taste and oily texture (Amerine, et al., 1972). Gentilini and Cappelleri (1959) found that glycerol production is aided by lower temperatures, higher tartaric acid content, and by addition of sulfur dioxide. According to Amerine and Roessler (1976), glycerol has a sweet taste and is found in all wines, but only in those made from botrytised grapes (those attacked by the mold Botrytis cinerea) will the concentration approach the absolute threshold of approximately 1.5 percent by weight.

Acetaldehyde

Acetaldehyde is a normal by-product of alcoholic fermentation, being the predecessor of ethanol in the alcoholic fermentation chain reaction. Although it has a pronounced

odor, and the threshold, as reported by Berg, et al., 1955b) of 1.3 to 1.5 mg. per liter in water, is well below the amounts found in newly-fermented wines, which is near 75 mg. per liter (Amerine, et al., 1972), it has little sensory importance since most wines have sulfur dioxide added, which fixes most of the aldehydes. In fact, Hinreiner, et al. (1955) found difference thresholds in table wines of 100 to 125 p.p.m. The wine in which acetaldehyde may most readily be identified is Spanish sherry due to oxidation of ethanol and to the activity of the flor yeast Saccharomyces bayanus (Amerine, et al., 1972). Amerine (1958) and Ough and Amerine (1958) reported accumulations of up to 1000 p.p.m. when the yeast is grown aerobically with a slight pressure and occasional stirring. Amerine, et al. (1972) found that Spanish sherries may have up to 500 p.p.m. and average over 200.

Volatile Acidity

The volatile acids present in wines are acetic, formic, butyric, propionic, and traces of other fatty acids (Amerine, et al., 1972). Lactic acid is a fatty acid and is not only a normal by-product of alcoholic fermentation, but is a product of the malo-lactic or the so-called "secondary fermentation" whereby malic acid produces lactic acid and carbon dioxide (Bell, 1976). It is, however, not very volatile nor is it a normal spoilage product in wines, so it is excluded from the

volatile acids list (Amerine, et al., 1972). Volatile acidity determination, as an indication of spoilage, is a standard enological procedure and has become a part of the legal requirements for wine standardization. Wines with an excess of volatile acidity have a spoiled vinegary character. Under section 240.1015, Title 26, Code of Federal Regulations (U.S. Internal Revenue Service, 1970), acetic acid may be used to correct natural deficiencies, provided the addition does not exceed 0.4 gallons of 100 percent acetic acid per 1,000 gallons of wine, and provided the acetic acid is not added in a solution of less than 50 percent. The acetic acid content may not exceed 0.14 gm. per 100 cc. in red wine or 0.12 gm. per 100 cc. in all other finished grape wines. Amerine, et al. (1972) stated that careful winemakers can produce wine with less than 0.030 mg. per 100 ml. of volatile acidity and that during aging this should not exceed 0.100 mg. per 100 ml.

Fixed Acids

The crushed grape juices (the grape must) contain tartaric, malic, and citric acids and these are found in the wines also, but in decreased amounts. Amerine, et al. (1972) stated that they are important not only for their acid taste, but also for their spoilage protection, color maintenance, and the fact that they provide a substrate for microbial attack. Lactic acid is, as mentioned, both a by-product of

alcoholic fermentation and a product of the malo-lactic fermentation. Malic acid is also reduced during the alcoholic fermentation, according to Peynaud (1947), to the extent of 10 to 30 percent. Citric acid from the grapes is attacked by various bacteria to produce acetic acid; citric acid in the wine is slowly decarboxylated during aging (Amerine, et al., 1972). Succinic acid is another by-product of alcoholic fermentation and is considered to be an important acid due to its high resistance to bacterial attack, its taste (which is vinous in character), and the fact that its ethyl ester may be an important odor component of some wines (Amerine, et al., 1972).

Acidity determinations are made by calculating the total (titratable) acidity (expressed as g/100 ml. of tartaric acid) according to a procedure developed by Guymon and Ough (1962), and the volatile acidity (expressed as g/100 ml. of acetic acid). The fixed acidity is simply the difference between the total and volatile acidity (Amerine and Ough, (1974).

Sugar

According to Amerine and Ough (1974), in varieties of Vitis vinifera, the predominant sugars are glucose and fructose. Small amounts of sucrose and other sugars are present, and in some varieties of Vitis labrusca (the native

American vine species) and its hybrids, sucrose may constitute as much as 25 percent of the total sugar. Bell (1976) stated that it is a common practice in some wine-producing regions to add sugar when the grape musts are deficient in sugar. If this were not done, inadequate alcohol would be produced and the wine would be unstable, susceptible to spoilage, and taste weak and watery. Addition of sugar is legal in many countries but is carefully regulated in the famous wine regions. After the grapes are crushed and during alcoholic fermentation, the sucrose is hydrolyzed and fermented (Amerine and Ough, 1974) so it should not matter whether the fermentation substrate comes from the grape or from a bag since there is no difference in the chemical reaction. From a sensory standpoint, however, it does appear to make a significant difference for, as Schneider (1977) pointed out, adding sugar to the juice of unripe grapes will increase alcohol, but it cannot replace the aroma and flavor of naturally ripe grapes. Regardless of whether sugar is added or is naturally present in the grapes, little sucrose remains in the finished wine, although some wines may have considerable reducing sugars left in them when the fermentation is completed. This was explained by Meinhard (1976), and is due to cases in which the grape must is made from grapes which have reached a high degree of maturity and hence have a very high sugar content. This sugar content is so high that when the fermentation produces sufficient alcohol

to stun the yeasts and stop the fermentation, a considerable amount of residual sugar is left. Amerine and Ough (1974) said that truly "dry" wines contain less than 0.1 percent reducing sugar and much of this is probably due to nonfermentable reducing sugars such as pentoses. They further stated that, from a sensory point of view, "dryness" is a relative term varying with the wine type and the individual. With some low-alcohol white table wines, the threshold for sweetness is the same as in water, i.e., about 0.4 percent. In red wines, however, it may be as high as 1-1.5 percent. This is explained by Berg, et al. (1955a) who found that tannins increase the absolute and difference thresholds of sugars.

Tannins

According to Amerine, et al. (1972), tannins occur in the skins, stems, and seeds of the grapes and are classified as hydrolyzable (those which are like esters in character and can be broken down by hydrolysis), and condensed (where the nuclei are held together by carbon linkages). During aging of the wines, the tannin content decreases, due to combination with aldehydes, to precipitation with added or natural proteins, and to other reactions (Amerine, et al., 1972). This is why mature red wines will lose their tannic edge and become much softer in taste.

Color

Red wines become lighter in color as they mature, a process which occurs both in barrel and in bottle (Bell, 1976). Ribereau-Gayon and Stonestreet (1964) considered this to be a result of a gradual passing of the anthocyan pigments to a colloidal state and precipitating, which not only removes color pigments, but allows the yellow-brown color of the tannins to be seen. This yellow-brown color increases with age as the tannins condense. Amerine, et al. (1972) stated that oxidation of the pigments also contributes materially to the increase in brown color. White wines, contrary to red wines, become darker as they age (Bell, 1976). Amerine, et al. (1972) stated that this is due largely to the oxidation of phenolic compounds, such as catechins and leucoanthocyanins, and the rate at which this occurs is dependent upon the amount of phenolic compounds, the temperature, and the amount of dissolved oxygen in the wine.

Effects of Heat on Alcoholic Beverages

The references here, as in the section on wine components, are primarily drawn from the scientific literature.

Alcohol

Table 1 (Rietz and Wanderstock, 1965) shows the boiling point of mixtures of alcohol and water and of dry table

Table 1. Boiling point of alcohol and water mixtures.[1]

Percent alcohol in liquid by:		Boiling temperature (Interpolated) International Critical Tables	
Weight	Volume	°C	°F
6.5	8.0	92.5	198.5
8.1	10.0	91.2	196.2
9.7	12.0	90.3	194.5
12.0	14.8	89.1	192.4
16.3	20.0	87.5	189.5
	Dry Wine		
9.9	12.2	90.2	194.4
	Sherry Wine		
16.1	19.8	87.3	189.2
	Brandy and Rum		
37.0	44.0	82.4	180.3

[1]Rietz, C. A., and Wanderstock, J. J., 1965 "A Guide to the Selection, Combination, and Cooking of Foods," AVI Publishing Co., Inc., Westport, Conn., p. 340.

wines, sherry wine, brandy, and rum. A liquid of pure alcohol has a boiling point, at sea level, of 78°C (17].4°F), while distilled water will boil at 100°C (212°F). As Table 1 shows, the boiling temperatures of various alcohol/water mixtures, including wines and spirits, are well above the volatilization temperature of alcohol and somewhat below that of water. The alcohol, therefore, would be expected to quickly boil off in open pot cooking (Rietz and Wanderstock, 1965). As it does so, the boiling temperature will increase due to the greater concentration of water in the mixture, but the alcohol should be gone before the water portion begins vaporizing. The alcohol content of wines is perhaps overemphasized in cooking. It is interesting to note that there are many other flavoring ingredients used in cooking which have a far higher alcoholic content than do wines. As Barbour (1959) pointed out, vanilla extract is usually 40-50 percent alcohol and even fortified wines, such as Port and Sherry, seldom exceed 20 percent.

Color

Color is one of the most important sensory attributes of wines, including white wines. Inherent colors are altered by heat (Rietz and Wanderstock, 1965) and this can affect foods cooked in wine. Much of what the winemaker does is concerned with color, either putting it into the wine or altering it during processing and aging. In Port making, for example,

the primary problem is color extraction from the grape skins, since the fermentation is arrested purposefully by the brandy fortification. The traditional method used in the Duoro Valley, to assure sufficient color extraction, was for the workers to trod the grapes endlessly prior to fermentation. Today, this has more or less been replaced by pumping during fermentation to achieve agitation. In California they heat the grape musts by pumping through a pasteurizer and returning to a vat until the temperature reaches 49°C (120°F), whereupon it is held at that temperature for approximately twenty-four hours (Amerine, et al., 1972). Joslyn and Amerine (1964) suggested heating to a higher temperature (60°C - 140°F) for a shorter time. Amerine and DeMattei (1940) have shown that good color extraction can be attained immediately by dipping the grapes in boiling water, for one minute, before crushing. Coffelt and Berg (1965) developed steam pressure equipment for heat treating whole grapes at very high temperatures for only a few seconds and found that after the partial fermentation and fortification the Ports were of superior color. There are two other wine types, Madiera and California Sherry, which are ordinarily treated with heat but, in their case, it is the wine itself which is so treated, not the grapes; the effect is not to strengthen the color but to weaken and alter it. Madiera is fermented dry, partially fortified, and baked at not over 60°C (140°F) for three to four months in concrete

tanks and then re-fortified (Amerine, et al., 1972). The baking of California Sherry results in a slight carmelization of the sugars as well as a certain degree of oxidation (Amerine, et al., 1972). Amerine and Roessler (1976) stated that the heating of red wines may induce a tawney tint, but excessive heat causes browning (partially due to carmelization of the sugars). This has been noted by many popular food writers. Guillaume (1978) said that a good red wine changes color when cooked, becoming brownish and transparent, while a strong violet shade would be unacceptable.

Sweetness

According to Rietz and Wanderstock (1965), although the sugars may be subject to browning and carmelization, sweetness is practically stable and is retained. Most wine cookery is done with dry wines, although quality sweet wines offer interesting possibilities in connection with desserts. Most of the quality natural sweet wines (those which are sweet due to residual sugar remaining after the fermentation is complete, as opposed to being sweetened), such as the French Sauternes, German Auslesen and Beerenauslesen, are generally too expensive to be considered for cooking. One sweet wine, Port, is commonly used in cookery and the stability of the sweet taste would be important. Sweetness in wines is due primarily to the reducing sugars glucose and fructose, but, to a lesser

extent, glycerol and ethanol are responsible as well (Amerine and Roessler, 1976). Normal table wines contain 0.5 to 1.5 percent (by weight) of glycerol (Amerine and Joslyn, 1970) and the detection threshold is about 1.5 percent. Ethanol not only has a "sweet" parameter, but enhances the apparent sweetness of sugar solutions as well (Amerine and Roessler, 1976). The loss of alcohol during heating could thus result in decreased perception of sweetness.

As discussed, the sugars present in the wine would, under conditions of high heat or prolonged cooking, be expected to show some degree of carmelization. This evidently has more effect upon the color than it does on the product flavor.

Acids

Sourness is a function of the titratable acidity and the pH of the wine, but the actual sour taste of a wine is a complex function of numerous factors, among which are: the buffering capacity of the wine and of the person's saliva, the sweetness of the wine, and the particular balance of different acids (Amerine and Roessler, 1976).

According to Amerine, et al. (1972), the order of decreasing sourness of the principle organic acids of wine is probably malic, tartaric, citric, and lactic if the titratable acidity is the same for all the acids. The ratio, in wines, of these acids is quite variable and depends upon many

factors. They are considered to be fixed acids and should not be lost during heating. Some acids are volatile, which refers to the volatility with steam of the fatty acids. Volatile acidity in wines is expressed as g of acetic acid per 100 ml of wine (Amerine and Ough, 1974). High volatile acidity generally indicates that spoilage organisms, particularly Acetobacter, are present (Amerine and Ough, 1974) and, as such, is rigidly limited by both Federal and California laws. With wines of high volatile acidity, spoilage is readily apparent and it is not likely they would be used for cooking but, if they were, the volatile acids would dissipate since they would be exposed to steam during the cooking process.

Bitter Components

Amerine and Roessler (1976) stated that bitterness in wine is a taste that the inexperienced judge finds most difficult to evaluate uniformly because it is often confused with the tactile sensation of astringency. Polyphenolic compounds, especially the tannins, have two sensory characteristics: true taste bitterness and tactile astringency (Amerine and Roessler, 1976). Bitterness (or astringency) is normally found only in red wines since white wines contain .05 percent, or less, tannin (Amerine, et al., 1972). Taste thresholds have been reported by Berg, et al. (1955a) for grape-seed tannin of 0.02 g per 100 ml while Hinreiner, et al. (1955)

obtained a difference threshold of 0.10 g per 100 ml for a white table wine and 0.15 in a red. The importance of these phenolic compounds extends beyond the taste and tactile factors, for they are also responsible for the color (anthocyanins in red grapes), possibly cause pungent odors, are a reservoir for oxygen reduction, and are a source of browning substrate (Amerine and Ough, 1974). Not all the tannic substances come from the grapes, for complex tannin-like substances are extracted from the wood of barrels during aging, and these are normally the hydrolyzable tannins (Amerine and Ough, 1974). Rietz and Wanderstock (1965) stated that the bitter components vary with individual liquors; some liquors may have all bitterness removed by heating, others part, and some none.

Carbon Dioxide

According to Barbour (1959), sparkling wines do not have any place in actual cookery (except where they may be added when all the other ingredients are cold), because heating destroys their effervescence immediately by driving off all the carbon dioxide, making them less desirable than a good dry white wine. Rietz and Wanderstock (1965) said that the carbon dioxide evanesces quickly when the beverage is heated and leaves the warming liquor even faster than does the ethanol.

Aromatics

Rietz and Wanderstock (1965) stated that all aromatics are volatile and evanesce with temperature and time. Barbour (1959) stated essentially the same thing when he admonished against using expensive wines for cooking, since the delicate bouquet, which makes them expensive, will vanish at the first touch of heat. Sarvis and Thompson (1973) found that if the wine is barely heated, as in finishing a creamed chicken sauce with sherry, or heating a hot wine punch just to serving temperature, it can retain some aroma and bouquet. Amerine and Roessler (1976) found that heating red wines produces a "heated" or off-odor and the entrancing bouquet of a bottle-aged, high-quality red wine did not develop.

Flavor

Hatch (1941), in the American Wine Cookbook, maintained that every wine, from a culinary standpoint, has three flavors: its natural flavor, its simmered flavor, and its cooked flavor. He suggested that this can be best understood by dividing a wine into three portions. The first is tasted as it comes from the bottle, the second, after it is heated just to the simmering point and cooled, and the third, after it has been boiled vigorously for two or three minutes and cooled. As the wine is subjected to increasingly greater heat treatments, the flavor changes and is not as apparent,

becoming as he says "less masterful," allowing more liberal use. Sarvis and Thompson (1973) said that if wine is barely heated through, it can retain nearly all its flavor, but, when boiled or simmered the flavors change considerably for then the alcohol and other volatile flavoring components evaporate. According to them, the expected and hoped-for flavor effect is that of wine with a slightly bitter taste and a seeming permanence about it, rather than an evanescent freshness. They also found a concentration of flavor occurred as the wine volume became reduced during heating.

Functions of Wine in Cookery

Rietz and Wanderstock (1965) listed various functions of alcoholic beverages in cookery. As liquids, they are used as watery carriers and as diluents and hydrates. They are used as solvents since their acids and alcohol dissolve or tend to dissolve food substances not readily water-soluble, and as marination liquors for short-term flavoring and long-term preservation while flavor-altering and tenderizing. As flavorings, they are used primarily for the cardinal taste components. Natural alcoholic beverages have four of the five taste components: sweet, sour, bitter, and chemical. Although sweetness and acidity are the main contributions, there are secondary taste components, mainly astringency. Wines provide solids in the form of sugars, acids and color

pigments and finally there is what Rietz and Wanderstock termed the psychosomatic factors. These latter are primarily social for, other than in wine producing areas, wine is used in cookery mainly as a status food. More than any other flavoring component, the idea of wine seasoning has been elevated to exoticism in domestic and commercial practices. Ellis (1939) offered two reasons why wines have always been used in food: texture and flavor. The flavor is due to the dilute acids which are said to aid digestion and the fruit sugars which carmelize and add their own distinctive flavor to the dish.

According to Allen (1934), wines accentuate the natural flavor of a food, add flavor in cases where the foods involved have little natural flavor, and improve texture when they are added directly to meat to make it more tender or are combined with meat/fish in the form of a sauce. Meyer (1964) found that wine can be used in broiling, poaching, boiling, or baking and that it tenderizes, prevents dryness, increases juiciness, and enhances flavor immeasurably. A chef's point of view (De Gouy, 1947) was that wine, in cooking, acts as a flavoring only, although it also has the effect of conserving sugar in cookery, since alcohol makes sugar available in the human system. Conil (1962) stated that wine is not used merely for show, but for other reasons as well: for tenderizing and making food more readily digestible, for savourizing

(a term describing the action of the acidity of wine on the papillae of the tongue, helping the necessary salivary secretions), for aromatizing and complementing the food, for supplying the mineral salts lacking in meat and other foods rich in protein and fat, and for giving the food a new energy value in the form of calories. Sarvis and Thompson (1973) said that wine is a source of flavor and could be used in a number of ways. It could take the place of a poaching or simmering liquid, be used for basting, or be used in sauces either as the main constituent or a finishing one. It is used as a direct seasoning, as a tenderizer, as an addition of liquid content, and as an addition of acid content and acid action.

Wines, according to Buonassisi (1978), make dietary fats less unctuous, more appetizing, and more digestible. In addition, the non-alcohol components of wine, the acids, sugars, proteins, minerals, vitamins, enzymes, pectin, esters, aldehydes, and other tannic and color ingredients, have, at times, an antiseptic action. Taylor (1963) believed there are three primary ways in which wine may be used to enrich the flavors of meat and meat dishes. The first is the replacement of part of the water or other liquid in the recipe. The second is when it is used for basting, and the third usage is as a marinade prior to cooking.

In testing the penetration of salt and of heat into foods while being cooked, Carlheim-Gyllenskoeld (1970) reported

no difference in heat penetration in foods cooked in wine from foods cooked without wine.

Wine Usage: Marination and Preservation

Wines are valuable in tenderizing meat and dissolving calcium from bones (Davis, 1947), due to their acid content, and the use of wine in marinades is evidently a practice of long standing. One of the advantages of wine over a more highly acidulous medium, such as vinegar, was pointed out by Brown, et al. (1941) in that wine alters the texture and shortens the cooking time of tough meats, much as does vinegar, but without leaving an acid taste. These authors also advised that the more acid a wine has, the better it is for softening meats. On the subject of vinegar, Guillaume (1978) believed it to be a mistake to add any at all to a wine marinade, preferring instead, to use red wine entirely. Botsford (1952) said wine tenderizes and mellows meats. Since this is especially true of the cheaper cuts of meat and elderly fowl, the use of wine in cookery is an Old World heritage, for, in many countries, choice meats have always been scarce and expensive. Conil (1962) found that red meats, venison, hare, and game are improved by being soaked in red wine for several days. Sarvis and Thompson (1973) agreed with this and emphasized that wine has a tenderizing effect on meats and poultry, but must be used for a relatively long time, two to three days for

pot roast or rabbit. A wine marinade not only tenderizes and lends flavor but also serves to protect meat and fish from attacks by harmful exterior agents (Buonassisi, 1978; Smith and Minor, 1974).

Smith and Minor (1974) pointed out that methods used to tenderize meat are either mechanical, as in cutting, grinding, scoring, and pounding, or chemical, where proteolytic enzymes are used. They do not consider marinating to be a tenderizing procedure, for what takes place is a surface activity of acid hydrolysis of collagen and denaturing of surface protein material.

Increasing the hydration of proteins, by making the meat more acid or basic, may increase tenderness (Griswold, 1962). Increasing or decreasing the pH of meat reduces the loss of moisture from meat on heating and, therefore, acidulation of the meat by marination may be feasible, although research by Griswold (1955a; 1955b) showed that soaking beef round for forty-eight hours in diluted vinegar not only failed to increase tenderness, but also lowered acceptability. In that case, the pH of the meat was altered only slightly, due to the strong buffering effect of the meat. It may be that very large amounts of acid or base are required to change the pH and, if so, the tenderizing value of wine would be questionable since a typical wine acidity level would be about 0.5-0.8 percent with a pH of about 3.2-3.75 (Amerine and Roessler, 1976).

A method for preserving meat is described in a paper by Kunz-Cantienti (1968) where pieces of fresh beef, ham, or lean bacon are cooled to a temperature of 1-3°C and rubbed thoroughly with a mixture of 16-34 g. salt, 0.2-0.8 g. sodium nitrate, 2-6 g. pepper, 1-6 g. garlic/100 Kg. meat, and 0.2-1.0 L. red wine/100 Kg. meat. Clark and Goldblith (1975) described how, in ancient Rome, wine vinegar was widely used for the preservation of foodstuffs, and wine was used for preserving grapes and certain other fruits and vegetables. According to Rietz and Wanderstock (1965), when vegetables are steeped in wine or vinegar, the acids attack the cellulose sacs which bind the tissues. Since salt tends to harden tissues of meats and vegetables, it should not be used in tenderizing marinades.

Cooking With Wines: Specific Products

The use of wine in food preparation appears to be a widespread practice, since it is common to find references, in the literature of food research, to specific foods which have been made with wine. Hill and Glew (1970), in a test designed to ascertain the effect of delay between cooking and freezing upon food flavor, used, as one of the samples, sole in wine sauce. Coq-au-vin was used by Gauthier (Anon., 1974) as one of the items successfully processed in a liquid nitrogen freezing system and by Hill and Glew (1973) who did

an organoleptic assessment of products frozen both by liquid nitrogen and blast freezing. Camerlingo and Procida (1971) applied for a patent (West Germany) on a preparation method of a veal/ham/cheese dish which was steeped in a wine sauce prior to being frozen. The technology of production of canned quail in wine was described by Khlebnikov, et al. (1971) as was a process for canned mushrooms a la Greque (mushrooms in a wine sauce) by Steinbuch and Slootman (1975). In an experiment on interrupted cooking of beef rib eye steaks, Korschgen and Baldwin (1971) found that a sauce seasoned with ground pepper and lemon juice was preferred to one containing burgundy wine.

Wines are evidently on the threshold of entering the "instant" category as have many other foods and beverages before it. Bohrman and Herbig (1971) applied for a patent (German Federal Republic) for a non-alcoholic, dry product from wine, to be used for flavoring dry foods such as soups, sauces, desserts, stewed fruits, or for making a wine substitute for alcoholics and diabetics. Lawry's Foods have made use of the idea for they have marketed burgundy, sherry, and white wine dry sauce mixes in which the wines are spray-dried into a dry mix (Anon., 1973).

MATERIALS AND METHODS

Ingredient Procurement

Sixty-two chickens with a mean weight of 2.81 lbs. were obtained from Michigan State University Food Stores. Lobster base was donated by the L. J. Minor Corporation of Cleveland, Ohio. The base showed the following product profile according to the Minor Corporation: cooked lobster, monosodium glutamate (vegetable protein derivative), salt, butter, flavoring, tomato paste, and vegetable gum.

Virginia Dare cooking sherry was obtained from the Kellogg Center. The other wines were purchased from a local retailer. They were: Red: Holland House Red Cooking Wine, Foppiano Zinfandel (non-vintage), Carneros Creek Zinfandel, 1975; White: Holland House White Cooking Wine, Gallo Chablis Blanc (non-vintage), Sterling Vineyards Chenin Blanc, 1976; Sherry: Christian Brothers Dry Cocktail, Duff Gordon Fino. The brandy used for the bisque was Christian Brothers California Brandy and was drawn from the stock of cooking spirits available in the food laboratory of the School of Hotel, Restaurant and Institutional Management.

Common lots of bacon, fresh mushrooms, onions, shallots, garlic, bread flour, celery, parsley, bay leaves, thyme,

eggs, half-and-half, and salt and pepper were obtained from the Kellogg Center. These were requisitioned in the amounts needed for each testing day. Unsalted sweet cream butter (Land O' Lakes) was purchased from a local food retailer.

The table wines were selected for their flavor compatibility with the Holland House cooking wines. Holland House White Cooking Wine is made from an imported French Sauternes and has some residual sweetness, so totally dry white table wines were eliminated from consideration. Holland House Red Cooking Wine is distinctively flavored, so a strong distinctive red wine was desired. The wines used showed the following analyses according to their manufacturers:

Holland House White Cooking Wine:

Volatile Acidity (as Acetic) - 0.06 percent
Total Acidity (as Tartaric) - 0.50 g/100 ml.
Reducing Sugars - 1.0 percent
Alcohol - 10.0 percent (by volume)
Salt - 1.5 percent

Holland House Red Cooking Wine:

Volatile Acidity (as Acetic) - 0.06 percent
Total Acidity (as Tartaric) - 0.50 g/100 ml.
Reducing Sugars - 0.2 percent
Alcohol - 10.0 percent (by volume)
Salt - 1.5 percent

Gallo Chablis Blanc:

Volatile Acidity (as Acetic) - 0.02-0.03 percent
Total Acidity (as Tartaric) - 0.65-0.70 g/100 ml.
Reducing Sugars - 1.0 percent
Alcohol - 12 percent (by volume)

This is a blended wine made from various grapes, mostly from the 1976 vintage with some 1977 blended in. It was purchased in May of 1978.

Foppiano Zinfandel:

Volatile Acidity (as Acetic) - 0.05-0.06 percent
Total Acidity (as Tartaric) - 0.6 g/100 ml.
Reducing Sugars - 0.2 percent
Alcohol - 12.0 percent (by volume)

This wine was made with Zinfandel grapes, primarily from the 1976 vintage with some 1977 blended in. The wine was purchased in May, 1978.

Sterling Vineyards Chenin Blanc, 1976:

Volatile Acidity (as Acetic) - 0.05 percent
Total Acidity (as Tartaric) - 0.75 g/100 ml.
Reducing Sugars - 0.5 percent
Alcohol - 12.5 percent (by volume)

Carneros Creek Zinfandel, 1975:

Volatile Acidity (as Acetic) - 0.045 percent
Total Acidity (as Tartaric) - 0.652 g/100 ml.
Reducing Sugars - 0.0 percent
Alcohol - 13.6 percent (by volume)

Virginia Dare Cooking Sherry:

Volatile Acidity (as Acetic) - 0.06 percent
Total Acidity (as Tartaric) - 0.4 g/100 ml.
Alcohol - 20.0 percent
Salt - 1.5 percent

The Christian Brothers Dry Cocktail Sherry:

Volatile Acidity - 0.06 percent
Total Acidity (as Tartaric) - 0.45 g/100 ml.
Alcohol - 16.0 percent

Duff Gordon Fino Sherry: Data are averages for Spanish Finos as reported by Valaer (1947):

Volatile Acidity - 0.08 percent
Total Acidity (as Tartaric) - 0.454 gm/100 ml.
Alcohol - 19.28 percent

Data on the analyses of wines, in most cases, is an average of the type made at a particular time. Depending upon the specific batch of grapes used and the uncontrollable variations in fermentation and the winemaking process, there will be some differences among batches, even though they may be the same type. This is alleviated, to some degree, with those wines which are blended, rather than vintaged, but not entirely. These differences among bottles, at time of manufacture, will be accentuated by holding time and holding conditions, such as heat, exposure to light, and degree and amount of movement.

According to Smith (1979), it is difficult to maintain consistency in the cooking wines because the base product, the wine, is so variable from year to year, and also within a particular year. Chromatographic comparisons, even of apparently similar wines from the same year and maker, showed striking differences which were not always recognizable from an organoleptic standpoint. Due to these problems, there is much experimentation in Europe with powdered wine bases for cooking, because of their greater consistency.

Ingredient Pre-preparation

The chickens were delivered whole, packed in crushed ice, within two days of slaughter. They were split and quartered according to the following procedure: The chickens were laid on their sides with the tail-end facing away from the cutter. A cut was made with a heavy chef's knife starting at the tail and cutting along the backbone until the bird had been split in half. The chickens were then turned over so that the tail-end would face the cutter and another cut was made along the backbone, freeing it completely from the main body of the bird. The backbone was reserved for chicken stock. The fully split chickens were spread flat, skin side down and, with the fingers, the breast bone was removed. The bird was divided into halves by cutting between the breast.

Each chicken half was divided into quarters and the full leg further split into the thigh and drumstick. The drumsticks were not required for the testing and were frozen for another use. Each breast quarter had the wing removed by cutting between the junction of the wing and the breast. The left and right side thighs and breasts were kept together so they would both be used in the same taste session to minimize differences between birds.

Two thighs and two breast quarters were wrapped together in packages of two with plastic food film. Trays of sixteen pieces were put into a Sears Kenmore reach-in freezer which had a temperature of -21°C (-5°F). Final wrapping was done the next day when four packages of two breasts or thighs each were wrapped together in aluminum foil, labeled, and returned to the freezer. Each test required two packages of breasts (sixteen pieces for poaching), and two packages of thighs (sixteen pieces for braising).

Stock was made from the chicken backbones in sufficient quantity for all six replications. Each preparation session required eleven cups of stock, ten for the poaching liquid (breasts), and one for the braising liquid (thighs). Backbones, weighing 9.4 kg, were placed into a ten-gallon cast aluminum stock pot and cold water was added. When the liquid came to a full rolling boil, the surface was skimmed to remove the insoluble materials which had collected there and a mirepoix consisting of 2.25 kg of coarsely chopped celery, carrots and onions, in a ratio of 1:1:1, were added along with one-half bunch of parsley and two bay leaves. The stock was not seasoned with either salt or pepper. The heat was turned down when the liquid had returned to a boil and the stock simmered slowly for three hours.

At the end of the cooking period, the stock was strained through a fine china-cap strainer to separate the liquid from the vegetables and bones. Since a considerable amount of fat had been rendered from the skin and flesh, the stock was defatted with a kitchen ladle and by blotting the surface with paper towels. Cooling was accomplished by placing the pot in a large sink filled with cold water and ice cubes. The pot was covered and stirred approximately every five minutes until the temperature dropped below 10°C (50°F). It was divided into six, one gallon portions and frozen.

Lobster Bisque

Sample Preparation

The lobster bisque was made from a formula developed by the L. J. Minor Corporation of Cleveland, Ohio. The product was made on three separate occasions in standard batches of 9.5 liters each. The formula is given in Table 2. The only difference among the samples, when served, was the sherry wine used for flavoring.

All the ingredients were weighed to the nearest gram, prior to preparation, and held ready. The water was divided in half and placed into two, one gallon Groen tilting steam-jacketed kettles, brought to a boil, turned off and held hot until needed. Each sherry sample was mixed with brandy in

Table 2. Formulation for lobster bisque.[1]

Ingredients		Amount
Butter - unsalted	g	448.0
Flour - bread	g	448.0
Lobster base	g[2]	252.0
Water	l	7.6
Cayenne pepper	g	1.5
Half-and-half	ml	940.0
Sherry	ml[3]	240.0
Brandy	ml[4]	120.0

[1]Yield = 9.5 L.

[2]L. J. Minor Co., Cleveland, Ohio

[3]80.0 ml. each of:

Virginia Dare Cooking Sherry
Christian Brothers Dry Cocktail Sherry
Duff Gordon Fino Sherry

[4]Christian Brothers California Brandy, divided into 40.0 ml. samples.

the ratio of 2:1. These were held in separate containers to be added immediately prior to serving. Each container was given a random code number.

The first cooking step was the preparation of a roux. A five-gallon cast aluminum stock pot was put on a Vulcan-Hart gas heated flat-top range and butter was added to it. When the butter had melted and was heated to the foamy stage, flour was mixed into it. The roux was cooked for three minutes while constantly being agitated with a french whip until the color was a light golden brown. When the roux was properly cooked, the lobster base was added and blended thoroughly. One gallon kitchen measures were used to transfer the hot water from the steam kettles to the roux-base mixture where the water was poured into the stock pot and the entire mass continuously whipped until smooth. This took a maximum of one minute and was done off the heat.

When the soup was well-blended and smooth, it was returned to the range where it was quickly brought to a boil. Cayenne pepper was then added. The heat was adjusted so that the soup would barely maintain a simmer. The soup simmered for fifteen minutes. While the soup was cooking, one quart of water was placed in one of the steam kettles to act as a hot water bath to warm the half-and-half. This was done by putting the cream into a one-half gallon stainless steel

steam table insert and placing the insert into the kettle. The water temperature was between 88° and 91°C (190° and 195°F).

When the soup had finished the simmering period, the heat was turned very low so that the soup would stay warm, but not simmer. The holding period for both the soup and the cream was necessary, since the samples were to be served to a dining room audience and the exact time of serving could not be accurately predicted. The temperature of the soup never dropped below 82°C (180°F) during the holding period, which ranged from eight minutes to a maximum of fifteen minutes.

When the dining room gave the kitchen a five-minute notice as to serving time, the soup was brought back to a full boil and the warm half-and-half was added. Following addition of the cream, the bisque was mixed until it returned to a boil, whereupon it was removed from the heat, taken to the serving area, and divided into three equal portions of approximately three liters each. One gallon stainless steel water pitchers, which had been coded with random numbers, were used to hold and serve the soup. These pitchers were pre-heated with boiling water and emptied immediately before being used for mixing and serving the soup. One of the three containers of the sherry-brandy mixture was added to each of

the identical soup samples and the contents were mixed with a wooden spoon.

Sample Presentation

The three samples were presented to guests, who were seated at seven tables of eight persons each, so the samples were set up in the kitchen on seven large oval hotel trays. Each tray had three dinner plates upon it and each plate had eight, two-ounce, portion cups on it. Each of the three plates was coded with a number corresponding to the three soup samples.

When the soups were completed with the sherry and brandy, three persons took the pitchers and began pouring portions of approximately 45 ml. (1.5 ounces). As each tray was completed, it was taken to the dining room where the three plates were placed on one of the tables. Each of the guests had been given a score sheet and a demographic questionnaire when they entered. After they were seated, their waitress explained that they were being asked to evaluate three soup samples. They were informed that the purpose of the evaluation was to determine whether any differences existed among the samples.

There was no attempt to formally randomize the order of presentation since the nature of the table set-up and sample presentation provided for a random selection of the

samples. The service personnel placed the three plates, at random, about the table and the guests selected the samples in any order they wished. They were instructed to evaluate each sample separately and cleanse their palates with water between samples.

Poached Breast of Chicken

Sample Preparation

The recipe (Table 3) for the poached breast of chicken was a modification of one taken from Mastering The Art Of French Cooking (Child and Beck, 1970). The modifications consisted of:

1. Boning the half breast prior to poaching rather than afterward. This was done to reduce the time span between the end of the cooking period and sample service by elimination of the boning step after cooking.
2. Substituting a chicken stock for half of the wine in making up the poaching liquid. This was done because using the cooking wine full strength would have resulted in an objectionably salty sauce.

Eight packages, of two breasts each, were selected at random, removed from the freezer the evening before each of the six tests, and placed in a 3.3°C (38°F) reach-in refrigerator overnight. Boning of the breasts was done the

Table 3. Formulation for poached breast of chicken.

Ingredient	Amount			
	Control	Holland House	Gallo	Sterling
Half-breast, (boned), g[1]	460.00	460.00	460.00	460.00
Stock, ml	480.00	240.00	240.00	240.00
Holland House, ml	0.00	240.00	0.00	0.00
Gallo, ml	0.00	0.00	240.00	0.00
Sterling, ml	0.00	0.00	0.00	240.00
Butter-unsalted, g	22.00	22.00	22.00	22.00
Flour, g	22.00	22.00	22.00	22.00
Egg, g	56.00	56.00	56.00	56.00
Half-and-half, ml	60.00	60.00	60.00	60.00
Salt, g	3.50	0.00	3.50	3.50
Salt and pepper mix[2]	V A R I A B L E			

[1]Weights given are the average for four boned half breasts.

[2]Prepared using 10.0 parts salt, 1.0 part M.S.G. and 0.1 part ground white pepper.

following morning, and the sixteen pieces were put into a shallow, full-length stainless steel steam table pan, covered with plastic film, and returned to the refrigerator. Prior to boning, the breasts had a mean weight of 190.0 g, with a range of 135.0-225.0 g. The boned breasts had a mean weight of 115.0 g with a range of 85.0-120.0 g.

Prior to the poaching process, the butter, flour, eggs, and half-and-half were all weighed and divided into four portions of each. The poaching was done in three quart stainless steel sauce pans. Two hundred and forty ml of chicken stock were added to each pan with an additional 240 ml added to the control. Each of the remaining three pans received 240 ml of the appropriate wine. Salt was placed into the control and the two table wine samples so that they would have the salt equivalent of the cooking wine/stock samples.

The four sauce pans were placed on a Vulcan-Hart commercial gas range with four open burners. The heat was turned to high, and the liquids brought to a rapid boil as quickly as possible. As soon as the liquid was boiling rapidly, four pre-weighed half breasts were placed in each pan. The breasts were completely submerged. When the liquid returned to a boil, the heat was adjusted downward until a slow simmer was maintained. The breasts were cooked to an internal temperature of 71°C (160°F), which normally took

approximately twenty minutes, depending upon the size of each breast. The temperature was recorded with a probe type pocket thermometer manufactured by the Taylor Co. When the breasts were done, they were removed and cut into six pieces each. A diagram depicting the cutting technique is given in Figure 1.

The breast pieces were placed into four, coded, stainless steel containers, covered, and placed into a hot water holding bath. The holding bath was made with two cast aluminum roasting pans measuring 36 inches long by 18 inches wide by 4 inches deep. Two gallons of hot water were placed in one pan, which was heated on a commercial electric range (General Electric) until it reached a full boil. The other roasting pan was placed inside the first, creating a large double boiler effect. One and one-half gallons of hot water were placed in the second (upper) pan. The range temperature was adjusted to maintain a boiling temperature in the bottom pan; the temperature in the upper pan stabilized at 80°C (176°F). This hot water bath was used to hold the poached and braised chicken pieces as well as their sauces.

Two cups of the poaching liquid were transferred to a one-quart aluminum kitchen measure; the sauce pan was wiped dry, and the butter was placed into it. This was done with each of the four pans. The sauces were then made, one at a time. A sauce pan was returned to the range and the butter

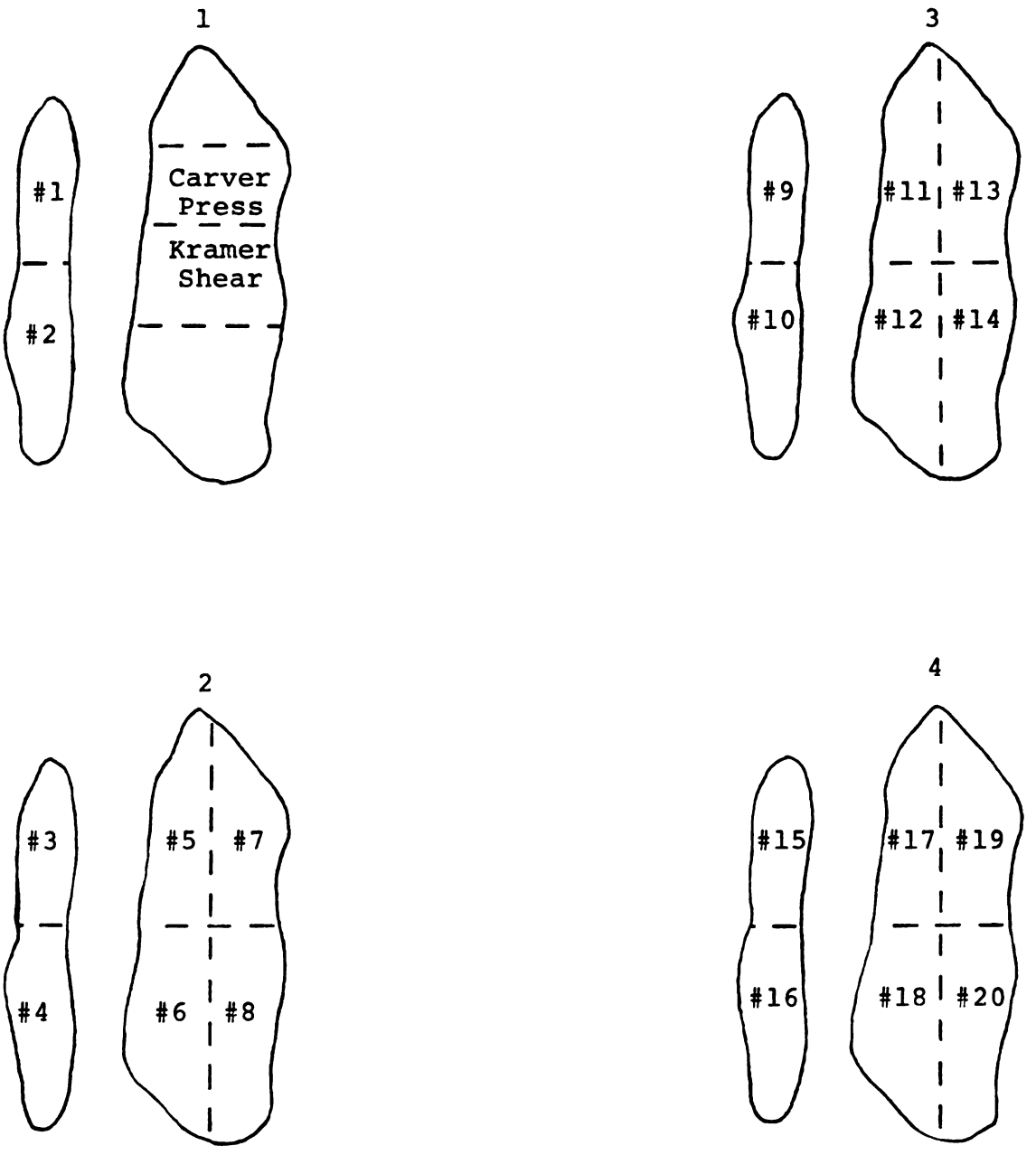

Figure 1. Cutting diagram for poached breasts.

melted. When the butter was foaming slightly, the flour was added and the roux mixed until smooth. The two cups of reserved poaching liquid were slowly poured in, while whipping constantly with a french whip. When the sauce was smooth and well-blended, the heat was turned down and the sauce held at a bare simmer while the other three sauces were prepared.

After all four sauces were ready, they were held over low heat until ten minutes prior to serving, when they were finished with a liaison of egg and cream. The procedure used for the addition of the liaison was as follows: The cream was well-blended with the egg and a portion of the hot sauce (10-15 percent) was mixed into the liaison. When they were well-mixed, this was repeated, and then the sauce/liaison mixture was added back to the main body of sauce while whipping constantly. The finished sauce was held in the hot water bath. The temperature of the sauce, at serving time, was between 77° and 80°C (170° and 175°F).

Sample Presentation

Each of the four samples was assigned a random number, drawn from a table of 2500 random numbers (Mosteller, et al., 1961) according to a method described by Mosteller (mosteller, et al., 1961). Different numbers were used for each replication. According to Sidel and Stone (1976), in order to

minimize the interactive effects of judge, product, and time, completely randomized designs are often less desirable than balanced-block designs which have been completely balanced for judge, order, and sample. The four-sample, balanced block design used (Sidel and Stone, 1976), is given in the Appendices.

The four samples were assigned tasting sequence numbers as follows:

Control (no wine)	No. 1
Cooking wine (Holland House-Red and White)	2
Standard table wine White - Gallo Chablis Blanc Red - Foppiano Zinfandel	3
Premium table wine White - Sterling Vineyards Chenin Blanc - 1976 Red - Carneros Creek Zinfandel - 1975	4

The tasting sequence was changed for each panelist at each replication, and the sequence for the entire panel was handed out at the beginning of each session. An example of the sequence used in one of the tasting sessions is given in the Appendices.

The procedure which was used required each panelist to examine the order of tasting, code all their score sheets, and then, in the proper order, pick up the samples from a designated area. Each sample was presented with its sauce, the sauce being separate on the plate so that the meat and the sauce could be evaluated independently of each other.

When one meat and sauce sample was finished, the panelist picked up the second and continued until all four samples had been scored.

Braised Thigh of Chicken

Sample Preparation

The recipe (Table 4) used for this preparation was a classic one for Coq-au-vin (chicken in wine), taken from Gourmets Basic French Cookbook (Diat, 1961).

The evening prior to each testing, eight packages, each containing two thighs, were selected at random, removed from the freezer, and held overnight in a 3.3°C (38°F) reach-in refrigerator.

After all the ingredients had been collected, there were some specific pre-preparation procedures which had to be completed before the actual cooking could begin.

1. Bacon: Dice finely. This was done by laying the strips of bacon flat on a tray and placing in the freezer until frozen. When the bacon was removed from the freezer and allowed to stand in the kitchen for a few minutes, it could be diced with more precision, and with cleaner cuts, than would otherwise have been possible.
2. Mushrooms: Approximately 0.5 mm was sliced off the stem ends and the mushrooms were then peeled.

Table 4. Formulation for braised chicken thigh.

Ingredients	Amount			
	Control	Holland House	Foppiano	Carneros Creek
Thighs, g[1]	616.0	616.0	616.0	616.0
Butter, g	14.0	14.0	14.0	14.0
Bacon, g	50.0	50.0	50.0	50.0
Mushrooms, g	75.0	75.0	75.0	75.0
Onions, g	112.0	112.0	112.0	112.0
Shallots, g	25.0	25.0	25.0	25.0
Garlic cloves, g	10.0	10.0	10.0	10.0
Flour, g	15.0	15.0	15.0	15.0
Stock, ml	250.0	0.0	0.0	0.0
Holland House, ml	0.0	250.0	0.0	0.0
Foppiano Zinfandel, ml	0.0	0.0	250.0	0.0
Carneros Creek Zinfandel, ml	0.0	0.0	0.0	250.0
Faggot:				
Celery, g	55.0	55.0	55.0	55.0
Parsley, g	3.0	3.0	3.0	3.0
Bay leaf, g	2.0	2.0	2.0	2.0
Thyme, g	3.0	3.0	3.0	3.0

[1]Weights given are the average for four thighs.

Peeling was done, rather than washing, to keep the mushrooms dry so they would saute more satisfactorily. Each peeled mushroom was cut into quarters and placed in a small pan.

3. Onions: The onions were peeled and cut into pieces measuring approximately 4.0 mm x 4.0 mm and placed into the pan with the mushrooms.
4. Shallots: They were peeled and diced very finely.
5. Garlic: The cloves were peeled, put through a garlic press and added to the diced shallots.
6. Faggot: This flavoring item was prepared by tying the celery, bay leaf, parsley, and thyme together.

When the pre-preparation procedures were completed, the thighs were removed from the refrigerator, unwrapped and placed on an aluminum sheet pan. The butter was placed in a 12-inch steel skillet which was set on a flat-top Vulcan-Hart range unit. This range was heated by three circular gas burners of varying diameters which were centrally located under a cast iron slab. The heat could be varied by adjustment of the flame height, or by placement on the range top. The burners were set at the 3/4 position and the range was pre-heated for a minimum of one-half hour. The surface temperature in the central portion was 274°C (525°F).

After the butter was melted, the diced bacon was added and cooked until the fat was almost completely rendered,

and the bacon was crisp and well-browned. This took approximately ten minutes. The bacon was then removed with a slotted spoon and reserved, while the bacon drippings/ butter combination was returned to the range and eight of the chicken thighs were added for browning. Prior to being placed in the hot fat, each thigh was patted dry with a paper towel. This was done so that the chicken pieces would color and crisp properly, and to reduce any steaming tendency (Child, et al., 1970).

When the pieces were well-browned, they were removed and held on a sheet pan while the remaining eight pieces were browned. As soon as all the chicken thighs were finished, the onions and mushrooms were placed in the pan and cooked until the onions became soft and began to develop some caramelization color. Approximately one-half of the accumulated fat was poured off, and the shallots and garlic were added and cooked for two and one-half to three minutes. Flour was added by sprinkling it over the onion/mushroom mixture and stirring it in with a wooden kitchen spoon. The entire mass was cooked until the flour became light brown in color.

This mixture was evenly divided among four, three-quart stainless steel sauce pans, which had been coded with random numbers. The sixteen pieces of chicken were divided into four portions and added to the sauce pans. Two hundred fifty ml. of either stock or wine were poured into each

chicken pan and topped with the reserved bacon dice and the faggot. The pans with stock and the two table wines had 3/4 teaspoon of salt added. The pans were returned to the range where each was placed on an individual gas burner. The wine was brought to a full boil, then adjusted so that it barely simmered. The pans were covered and the chickens were braised for approximately forty minutes or until an internal temperature of 94°C (201°F) was reached. The faggot was discarded; the chicken pieces were de-skinned and de-boned, and each piece was cut into five portions (Figure 2). The meat pieces were returned to the sauce, the pans were re-covered and placed into the hot water bath.

Sample Presentation

The procedure followed for sample coding and sequence of presentation were identical to those described for the poached breast of chicken.

Sensory Evaluation

Lobster Bisque

Sensory evaluation of the lobster bisque was conducted by using guests who attended dinners which were held as a class project by students in the School of Hotel, Restaurant and Institutional Management of Michigan State University.

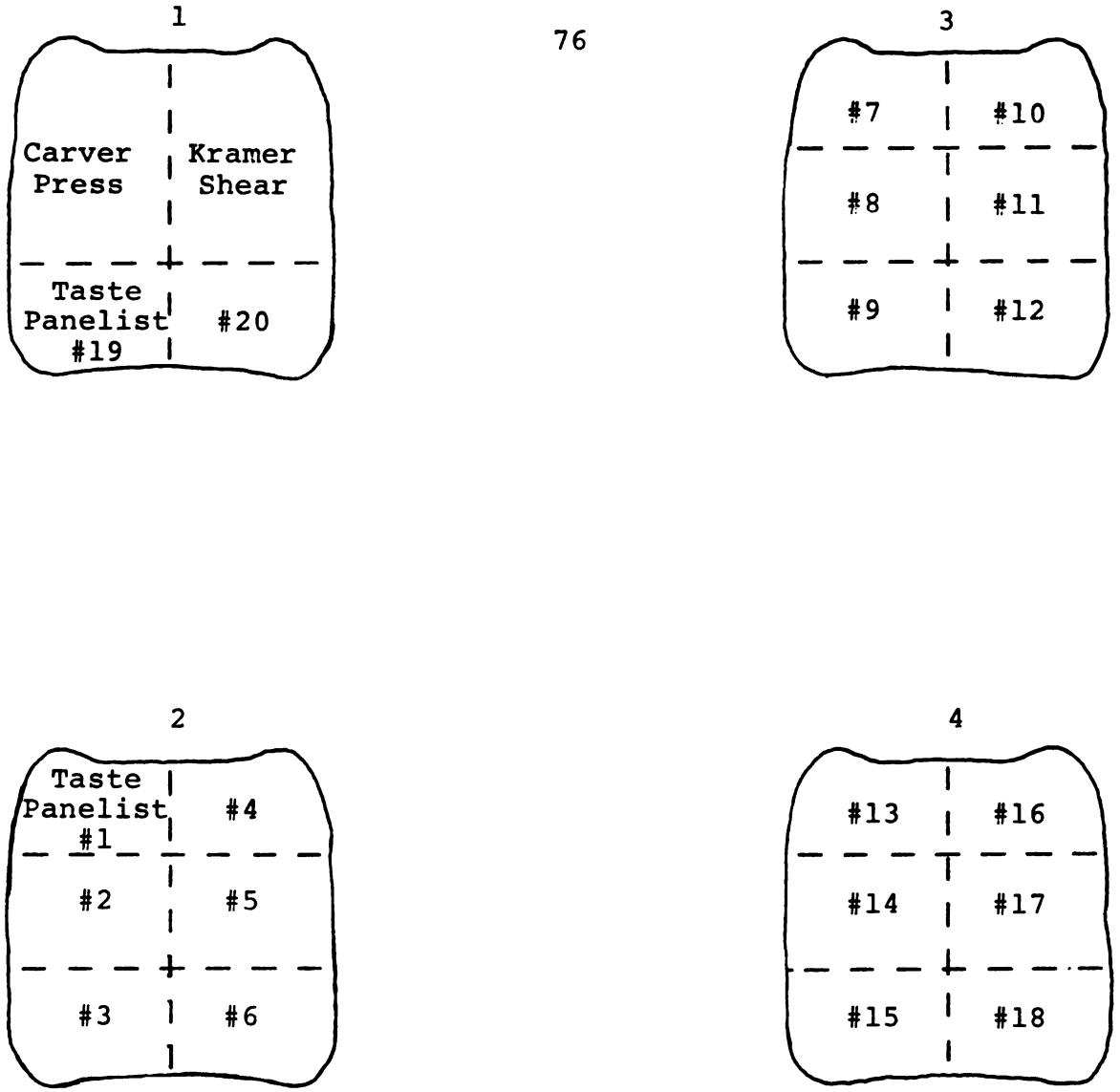

Figure 2. Cutting diagram for braised thighs.

The class, HRI 435, serves ten dinners per term for fifty to sixty persons each.

The three soup samples were evaluated by 156 untrained persons attending three dinners in November, 1977. They were not told the purpose of the evaluation, only that they were to indicate their feelings about the product on a nine-point, like-dislike hedonic scale. A sample score card appears in the Appendices. The persons attending the dinner were primarily associated with the University, either as students, or as faculty and staff. Persons not in these categories were usually related to the students who were managing the dinners.

Dinner attendees were asked to provide certain demographic data about themselves including their sex, age, and income range. They were asked to provide the following information about their experience, both with lobster bisque, and with wines: Have they eaten lobster bisque often enough to be familiar with how it tastes and smells, the relative frequency with which they eat foods prepared with wine, and how often wine is consumed as a beverage with meals. Their educational level was not requested, since it was known from experience that the persons who attend these dinners are more highly educated than the population as a whole. A sample questionnaire is included in the Appendices.

Chicken Breasts and Thighs

Sensory evaluation was performed by a panel selected from a group of students enrolled in HRI 455A, a senior level elective course on food evaluation and sensory perception, offered by the School of Hotel, Restaurant and Institutional Management. The class met from 3:00-5:00 PM on Wednesdays and Fridays during the Spring term, 1978, in a classroom adjacent to the food preparation facility used to prepare the products. Students participating in the study came to the Food Laboratory at 2:30 PM and evaluated either the breast or the thigh. The product not scored at that time was evaluated at 4:00 PM, during the class break period. The breasts and thighs were each evaluated an equal number of times at 2:30 PM and at 4:00 PM.

Nineteen members of the class participated in six panel sessions held during May and June, 1978. A training session was held prior to the first taste panel evaluation to acquaint the panel members with the score card, and the food standards which were to be used to evaluate aroma, tenderness, juiciness, flavor and color. They were instructed to use an identical score card for the sauce, but to limit the evaluation to aroma, flavor and color. A sample score card appears in the Appendices.

The actual evaluation was conducted in the Food Preparation Laboratory in Kellogg Center. The facility is

divided into two main sections, one consisting of the main battery of cooking equipment, the other, a series of individual work areas, each with a sink. Panel members went to the cooking area to obtain each meat and sauce sample and returned to the work areas for evaluation. They were instructed to cleanse their palates with water before evaluation.

Objective Measurement

Objective measurements were used to evaluate the quality of the poached chicken breasts and the braised chicken thighs. Quality characteristics determined were juiciness and tenderness. The chicken pieces were cut for evaluation according to Figures 1 and 2. Samples used for objective measurement were wrapped in aluminum foil and refrigerated overnight, then frozen at 021°C (-5°F). The thigh samples were de-boned and de-skinned prior to being cut and wrapped.

Juiciness

Juiciness values of the chicken pieces were determined using the Carver Press, which is designed to measure the amount of liquid, primarily water with some lipid material, which can be expressed from the product. The chicken pieces were weighed to the nearest 0.01 g before being placed between two canvas pads and then two felt ones. Three pieces of

chicken were placed in the press at one time and were subjected to a pressure of 1500 metric tons for five minutes. The pressed chicken pieces were weighed to the nearest 0.01 g and the juiciness value, expressed as percentage of press fluid, was calculated according to the formula:

$$\% \text{ press fluid} = \frac{\text{original weight - pressed weight}}{\text{original weight}} \times 100$$

Analysis of variance was used to determine whether there were any significant differences among the juiciness and tenderness scores or replications.

Tenderness

The tenderness values of the chicken pieces were determined using the Allo-Kramer shear press, which is designed to measure the lb. force per gram required to shear, or cut through the sample. Each piece of chicken was weighed to the nearest 0.01 g before being placed in the sample receptacle. The shear blades and the sample receptacle were thoroughly cleaned and rinsed between measurements.

The tenderness, expressed as lb. force/g, was calculated according to the formula:

$$\text{lb. force/g} = \frac{\text{ring (3000) x range (20) x reading}}{\text{sample weight x 100 x 100}}$$

Analyses of Data

A one-way analysis of variance was performed on the trained panel replications to determine whether there were any differences among the scores assigned by the judges during each replication. This was done for the sensory characteristics of aroma, tenderness, juiciness, flavor, and color on all samples of both the poached and braised chicken products. In addition, the same analysis procedure was performed for the sensory characteristics of aroma, flavor, and color on the respective sauces.

To determine whether any differences existed among products, a two-way analysis of variance was done on the mean scores assigned to the sensory characteristics for each of the four samples. This was repeated for both the poached and braised chicken preparations, as well as their sauces. The mean of the six replications was used as a score for each judge.

To determine whether there were any differences in juiciness or tenderness, as tested by the Carver and Shear presses, a two-way analysis of variance, on replications and samples, was performed on the data from the poached and braised chicken products.

One-way analysis of variance was performed on the data from the consumer soup panel to determine whether there were preference differences among the soup samples.

RESULTS AND DISCUSSION

Effects of Varying Wine Quality on Lobster Bisque Preference

The lobster bisque formulation was chosen for consumer preference studies because it is an item which is normally prepared with sherry wine and, since it could be prepared with a convenience food base, the products' sensory characteristics were standardized. Thus, any preference differences would be due to the flavoring ingredient, the sherry, and not differences in the basic product. Tables of mean scores, standard deviations and analysis of variance accompany this discussion. The bisque was prepared in a single batch at each of the three tasting sessions and divided into three equal portions, each of which was flavored with a different sherry.

A breakdown of the demographic characteristics of the consumers appears in Table 5. Comparison of the panel members' ages to Michigan or United States population statistics indicated that the panel substantially over-represented the under-25-year-old age group and tended to over-represent the 25-34-year-old age group. No attempt was made to ascertain the educational level, since virtually all the under-25-year-

Table 5. Demographic characteristics of lobster bisque consumer panel.

Age of Consumer	%
Under 25 years	57
25-34 years	23
35-44 years	5
45-54 years	8
55-64 years	5
Over 65 years	2
	100

Income Range of Consumer	%
Under $10,000	60
$10,000 - $14,999	13
$15,000 - $19,999	11
$20,000 - $29,999	9
Over $30,000	7
	100

Sex of Consumer	%
Male	43
Female	57
	100

Experience of lobster bisque consumer panel with product and with wine

A. Have you eaten lobster bisque enough times to be familiar with how it tastes and smells?	%
Yes	28
No	73
	100

B. This lobster bisque was prepared with wine. We want to know how often you eat foods prepared with wine.	%
Very often	16
Sometimes	40
Seldom	35
Never	9
	100

C. How often do you serve wine with your meals (both at home and away from home)?	%
Very often	20
Sometimes	43
Seldom	28
Never	9
	100

old age group were college students and many of the older panelists were either parents of the students (presumed to be college educated), or Michigan State University faculty members. The educational level was thus well above the average, for both Michigan and the United States. The income ranges tended to support this conclusion. The percentage of respondents under twenty-five years of age was 57 percent, while the percentage of respondents under $10,000 in income was 60 percent. There were 7 percent in the fifty-five-years-of-age-and-over category and 7 percent of the respondents claimed an income in excess of $30,000. These data would indicate that those under twenty-five years of age earn less than $10,000 and are students, while those over fifty-five years of age made over $30,000 and are most likely parents of college students, and university faculty. The response to the question of, "Have you eaten lobster bisque enough times to be familiar with how it tastes and smells?", was consistent with the preponderance of younger panel members. Seventy-three percent had not. The other two questions dealt with the panelists' experience with wine, and these data showed a strong degree of sophistication in this area. To the question, "This lobster bisque was prepared with wine. We want to know how often you eat foods prepared with wine," 56 percent indicated that they either very often, or sometimes did so. To the question, "How often do you serve wine with

your meals (both at home and away from home)?", an even greater number, 63 percent, responded that they very often, or sometimes did so.

Table 6 gives percentages of taste preferences, mean scores, and standard deviations for the lobster bisque prepared with three different sherries. In all three samples, there were considerably more respondents who liked, rather than disliked, the bisques. The data did, however, show significant differences in the degree of acceptability. The lobster bisque prepared with the Christian Brothers showed that 88.4 percent liked the product to some degree, while only 7.7 percent disliked it. The Virginia Dare-flavored sample had similar data, 84 percent liked it and 9.6 percent disliked it. The imported sherry-flavored sample, Duff Gordon Fino, was not as acceptable, since only 67.9 percent liked it, while 26.3 percent did not. Some of the comments accompanying the negative scores for the Duff Gordon were: bland, too alcoholic, too much wine. These are apparently contradictory since the volume of wine, (and alcohol), was the same in all cases, yet some respondents felt it, (the wine), was the predominant flavor while others thought it lacking in wine flavor. Some said it was salty relative to the others, which may have some basis as Amerine and Roessler (1976) said that saltiness may be perceived in old, very dry flor sherries. A cheese character was also commented upon. Webb

Table 6. Taste preference percentages, mean scores and standard deviations for lobster bisque prepared with three different sherry wines (total population).

Degree of Preference	Score	Christian[1] Brothers %	Virginia[1] Dare %	Duff Gordon %
Like extremely	9	12.3	10.3	3.8
Like very much	8	36.1	30.1	19.9
Like moderately	7	31.6	23.7	28.8
Like slightly	6	8.4	19.9	15.4
Neither like nor dislike		3.9	6.4	5.8
Dislike slightly	4	5.8	3.8	9.0
Dislike moderately	3	1.3	1.3	8.3
Dislike very much	2	0.6	3.9	3.2
Dislike extremely	1	0.0	0.6	5.8
Mean Score		7.19	6.78	5.90
S.D.		1.38	1.70	2.14

[1]There is no difference between these scores at the .1 percent level of significance.

Table 7. Analysis of variance of data from consumer bisque panel (total population).

Source of Variation	DF	SS	MS	F Value
Samples	2	135.5	67.75	21.63***
Error	465	1456.56	3.13	

***Significant at the .1 percent level of probability.

and Kepner (1962) found that ethyl lactate is responsible for the cheese-like odor of certain flor sherries.

Table 7 gives the analysis of variance of data from the total population of the consumer panel. It shows that there were significant differences among the products' scores. The multiple-range test was applied to the data in Table 6 to determine which products were different. The results are shown by the subscripts in Table 2. There was no difference at the .1 percent level of probability between the bisques flavored with the Christian Brothers and the Virginia Dare sherries and both were considered to be superior to the one finished with the imported fino sherry. In this case, the hypothesis of no difference was rejected, but in an unexpected manner. The most expensive sherry was judged to produce the least acceptable lobster bisque.

Table 8 presents the mean scores and standard deviations for evaluations of the lobster bisque made by four segments of the total population; male, female, under-twenty-five-years, and over-twenty-five-years of age. Tables 9 through 12 are the analyses of variance of the data from each of these populations. Results of the multiple-range tests, which are designed to show specific differences, are shown by the subscripts in Table 8. The data in Table 8 are consistent with the total population, in that significant differences were found. In all four cases, the bisques

Table 8. Mean scores[a] and standard deviations for lobster bisque prepared with three different sherry wines. Male vs. female population and under-25 years of age vs. over-25 years of age.

Population	Sample	Mean Score	Standard Deviation
Male	Christian Brothers[1]	6.95	1.39
	Virginia Dare[1,2]	6.53	1.57
	Duff Gordon Fino[2]	5.92	2.21
Female	Christian Brothers[3]	7.35	1.39
	Virginia Dare[3]	6.96	1.77
	Duff Gordon Fino	5.88	1.97
Under 25	Christian Brothers[3]	6.99	1.58
	Virginia Dare[3,4]	6.64	1.67
	Duff Gordon Fino[4]	5.81	2.20
Over 25	Christian Brothers[3]	7.45	1.07
	Virginia Dare[3]	6.98	1.72
	Duff Gordon Fino	6.02	2.06

[a]Scoring was done on a nine-point hedonic scale with nine being the highest (see Appendices for score card).

[1]There is no significant difference between these scores at the 1 percent level of probability.

[2]There is no significant difference between these scores at the 1 percent level of probability.

[3]There is no significant difference between these scores at the .1 percent level of probability.

[4]There is no significant difference between these scores at the .1 percent level of probability.

Table 9. Analysis of variance of data from consumer bisque panel (male population only).

Source of Variation	DF	SS	MS	F Value
Samples	2	34.41	17.21	5.57***
Error	189	583.41	3.09	

***Significant at the 1 percent level of probability.

Table 10. Analysis of variance of data from consumer bisque panel (female population only).

Source of Variation	DF	SS	MS	F Value
Samples	2	106.24	53.12	16.86***
Error	273	860.38	3.15	

***Significant at the .1 percent level of probability.

Table 11. Analysis of variance of data from consumer bisque panel (over-25 population only).

Source of Variation	DF	SS	MS	F Value
Samples	2	70.39	35.20	12.69***
Error	192	532.33	2.77	

***Significant at the .1 percent level of probability.

Table 12. Analysis of variance of data from consumer bisque panel (under-25 population only).

Source of Variation	DF	SS	MS	F Value
Samples	2	65.89	32.95	9.75***
Error	269	909.98	3.38	

***Significant at the .1 percent level of probability.

flavored with the Christian Brothers sherry and the Virginia Dare cooking sherry were statistically similar to each other, as was found with the total population, but additional similarities were found as well. The ranking of the three products by all four population segments was the same as it was with the total population: bisques flavored with Christian Brothers were preferred, followed by Virginia Dare, and then Duff Gordon.

Male

In contrast to the statistical similarity between the Christian Brothers and Virginia Dare-flavored samples, there was no significant difference between the Virginia Dare and Duff Gordon-flavored bisques.

Female

The results were the same as with the total population; there was no significant variance between the mean scores of the Christian Brothers and Virginia Dare samples, while both were significantly higher than the Duff Gordon product.

Under-Twenty-Five-Years of Age

There was no significant difference between the Christian Brothers and Virginia Dare-flavored bisques but, of these, only the Christian Brothers was considered superior

to the Duf Gordon as the difference between Virginia Dare and Duff Gordon bisques was not statistically significant.

Over-Twenty-Five-Years of Age

There is a difference significant at the .1 percent level of probability but, as was found with the total population and the female population, it is only among the Duff Gordon and the other two. Between the Christian Brothers and Virginia Dare, there was no statistical variance in the mean scores.

In all cases, the Christian Brothers was considered to make a bisque with a flavor superior to that of a bisque flavored with Duff Gordon, the difference in scores being statistically significant. The Virginia Dare scores were not as conclusive; they were always ranked ahead of the Duff Gordon-flavored product but the differences were, in the case of the male and under-twenty-five population, not statistically meaningful.

Product Replicate Consistency

The hypothesis is that there is no difference between the sensory scores assigned to each product; in other words, each of the four products' aroma, tenderness, juiciness, flavor, and color are, statistically, the same. To prove this hypothesis, a two-way analysis of variance (judges X

samples) was done using each judge's mean score for the test sessions they participated in. Three-way analysis of variance (judges X samples X replications) was not done because of unequal n's (not every judge participated in each test). Prior to this analysis, a one-way analysis of variance was done on the replications to determine whether there were any significant differences in the scores assigned to the samples by each judge, over the six taste panel sessions. There was a total of sixty-four such tests made, twenty each on the poached breasts and thighs and twelve each on the respective sauces. The results of these tests are given in Tables 13-16.

Table 13, analyses of variance on tasting replications of the poached chicken breasts, shows that there were inconsistencies in the judges' scoring patterns, but these were limited to the quality characteristics of tenderness and juiciness, which should have been least affected by the presence, or lack of presence, of wine. With the quality parameters of aroma, flavor, and color, the judges scored all four samples consistently and there were no statistical differences among replications.

Table 14, analyses of variance on tasting replications of the poached breast sauce, shows an inconsistency in scoring only the flavor characteristic of one product, the one prepared with stock instead of wine. The other eleven tests showed scoring consistency on the part of the judges.

Table 13. Analyses of variance on tasting replications of poached chicken breast.

Characteristic	F Values[1]			
	Control	Holland House	Gallo	Sterling
Aroma	.43	1.09	.64	.87
Tenderness	4.05**	.52	2.63*	.27
Juiciness	5.29***	2.31	5.25***	.55
Flavor	2.28	1.27	.67	.25
Color	1.64	.58	.63	.67

[1]DF = 5.
*Significant at the 5 percent level of probability.
**Significant at the 1 percent level of probability.
***Significant at the .1 percent level of probability.

Table 14. Analyses of variance on tasting replications of poached chicken breast sauce.

Characteristic	F Values[1]			
	Control	Holland House	Gallo	Sterling
Aroma	.54	2.02	1.40	.86
Flavor	7.72***	.32	1.10	.46
Color	.91	.23	.50	1.15

[1]DF = 4.
***Significant at the .1 percent level of probability.

Table 15. Analyses of variance on tasting replications of braised chicken thigh.

Characteristic	F Values[1]			
	Control	Holland House	Foppiano	Carneros Creek
Aroma	1.19	.14	.63	.30
Tenderness	.48	.15	1.00	.52
Juiciness	1.78	.88	1.82	1.10
Flavor	1.75	1.99	1.11	2.27
Color	1.15	1.26	.45	.94

[1]DF = 5.

Table 16. Analyses of variance on tasting replications of braised chicken thigh sauce.

Characteristic	F Values[1]			
	Control	Holland House	Foppiano	Carneros Creek
Aroma	.23	1.02	.52	.98
Flavor	.87	.93	.53	.30
Color	.80	1.78	.59	.50

[1]DF = 5.

In both Tables 15, (analyses of variance on tasting replications of thighs), and 16, (analyses of variance on tasting replications of the thigh sauces), the judges scored the product quality characteristics of all samples consistently and there were no statistical differences between taste panel replications.

Mean scores were, therefore, used for each judge in a two-way analysis of variance to test whether there were any differences in either the aroma, tenderness, juiciness, flavor, or color of the products.

Poached Breast of Chicken in White Wine

Chicken breasts were chosen for the study, since they represent a meat type which is mild and would not provide flavors which might tend to dominate the wine. Rietz and Wanderstock (1965), on their gustametric chart of scaled flavor intensities, list chicken lower than all other poultry and fowl, and below all but a very few other proteinaceous foods. The poaching method was chosen since the poaching liquid afforded an ideal medium with which to prepare sauces. Sauces made from the reduced (concentrated by boiling down to a reduced volume) poaching wine should provide a fair test as to what happens to the wine from a sensory standpoint. The poaching method is also one of classic simplicity and

results in monodimensional sensory perceptions. The only flavors which could have been introduced to the chicken were those from the wine.

Sensory Evaluation

Table 17 presents the mean scores and standard deviations of all the quality characteristics of the poached chicken breasts, as measured by the judges' sensory evaluations. The products prepared with Gallo and Sterling Vineyards wines tended to be scored higher than those made with no wine (control), and the cooking wine (Holland House), but in most cases there were no statistical differences among the scores. As regards the sensory characteristics, the highest scores were given to color, and the lowest to aroma. The aroma, as shown by the standard deviations, was also the category in which there were the widest range of scores, indicating less agreement on this sensory characteristic than on the others.

Table 18 presents the analyses of variance of the data in Table 17. There was a clear difference, significant at the .1 percent level of probability, between the raw scores assigned by the judges, but not necessarily between the products. This was consistent with results from the braised thighs as well as the two sauces. The judges, even though familiar with the principles of sensory perception

Table 17. Mean scores[a] and standard deviations for sensory evaluation of quality characteristics of poached breast of chicken prepared with three different white wines and for one sample prepared without wine.

Sensory Characteristic	Prepared With	$\bar{X}$ Score	Standard Deviation
Aroma[b]	Sterling	7.43	2.73
	No wine (control)	6.99	3.03
	Gallo	6.98	2.54
	Holland House	6.84	2.56
Tenderness	Gallo[1]	9.43	1.61
	Sterling[1,2]	9.04	1.95
	Holland House[1,2]	8.62	2.24
	No wine (control)[2]	8.44	2.04
Juiciness	Gallo[1]	8.36	1.41
	Holland House[1,2]	7.84	2.13
	No wine (control)[1,2]	7.63	1.54
	Sterling[2]	7.49	1.84
Flavor[b]	Sterling	9.22	1.55
	Gallo	9.21	1.52
	Holland House	9.09	1.56
	No wine (control)	8.61	1.33
Color[b]	Gallo	9.57	1.97
	Sterling	9.57	2.24
	No wine (control)	9.45	2.02
	Holland House	9.35	2.05

[a]A thirteen-point hedonic scale was used for sensory evaluation with 13 being the highest. See Appendix 5 for the score card.

[b]There are no significant differences among samples.

[1,2]There are no significant differences among these products at the 5 percent level of probability.

Table 18. Analyses of variance for taste panel palatability factors for poached chicken breast.

Source	DF	F Values				
		Aroma	Tenderness	Juiciness	Flavor	Color
Judges	[1]	36.56***	16.36***	14.38***	10.95***	87.92***
Products	3	1.02	3.37*	2.86*	1.82	.68

[1]Aroma, color DF = 11.
Tenderness, juiciness, flavor DF = 13.
*Significant at the 5 percent level of probability.
***Significant at the .1 percent level of probability.

and trained in the use of the score card, were using different standards of reference in scoring. Some judges tended to score higher or lower than others but, since they were doing so consistently, it resulted in a difference in score magnitude rather than a real variation in scoring. Testing was being done to determine whether differences attributable to the wines used could be detected, not as to the relative acceptability of the various products. These scoring patterns were evaluated to determine whether there was any relationship between high or low scores with sex, age, geographical background, or previous wine experience of the judges. The scoring patterns were unrelated to these factors.

The quality factors of aroma, flavor, and color were not significantly affected by the wine used. In fact, there were no statistical differences among the products poached in the three wines and the control (the sample prepared without wine). The quality factors of tenderness and juiciness both showed a difference, significant at the 5 percent level of probability. To determine which product means were significantly different, a multiple-range test (Amerine, et al., 1965) was applied to the data from Table 18. The shortest significant ranges were calculated by multiplying the tabular values of Qp by the standard error. The results are shown by the postscripts in Table 17. In the scores for tenderness, the three products made with wine show no significant

difference from each other. Two of them, however, breasts poached with the Sterling Vineyards and Holland House wines, also show no significant difference from the control. Only the breast poached in Gallo wine was, statistically, more tender than the one poached in stock alone. Data from the Shear Press (Table 21) do not support the judges' perception as it showed no differences among the samples. In the juiciness results, as was found with the tenderness results, the Gallo-poached sample had the highest mean sensory score, but it was not statistically different from either the breasts prepared in Holland House cooking wine or in stock (no wine). The product prepared in Gallo did score significantly higher than the breast poached in the Sterling Vineyards Chenin Blanc. Neither the chicken prepared with Holland House cooking wine nor the stock-poached product had a significantly higher score than that prepared with the Sterling. The quantitative data relative to juiciness, as measured by the Carver Press (Table 19), showed no real differences among samples.

The hypothesis that there is no difference is partially rejected. There were significant differences with the characteristics of tenderness and juiciness, but only with the juiciness was there a variance among the breasts prepared in wine. The tenderness scores showed that the three samples prepared in wine had statistically similar scores. The palatability factors most likely to be affected by the use of

Table 19. Data from Carver Press testing of poached breast and braised thigh of chicken.

Chicken Piece	Prepared With	Mean % Press Fluid	Standard Deviation
Breast	Holland House	54.79	1.10
	Sterling	53.23	1.92
	No wine (control)	52.97	2.64
	Gallo	51.68	1.94
Thigh	Foppiano	53.20	5.89
	Holland House	50.51	5.08
	No wine (control)	50.49	2.28
	Carneros Creek	49.76	2.86

Table 20. Analysis of variance of data from Carver Press testing of poached chicken breast.

Source of Variation	DF	SS	MS	F Value
Replications	3	13.83	4.61	1.26
Samples	3	19.64	6.55	1.78
Error	9	33.02	3.67	

Table 21. Data from Shear Press testing of poached breast and braised thigh of chicken.

Chicken Piece	Prepared With	Mean Lb. Force/gm.	Standard Deviation
Breast	Holland House	6.08	2.55
	Sterling	6.12	2.20
	Gallo	7.55	1.22
	No wine (control)	8.16	6.00
Thigh	Foppiano	4.19	1.65
	No wine (control)	4.33	1.33
	Holland House	4.90	1.42
	Carneros Creek	5.51	1.13

wines in general, and by varying the wines, were aroma and flavor, and with these, the hypothesis was supported; there were no differences among breasts of chicken poached in dissimilar wines.

Objective Measurement

Carver Press--Results of the Carver Press test for juiciness, mean percentages of press fluid from four replications and the standard deviations for each sample, are presented in Table 19. The product prepared with the cooking wine, Holland House, yielded the greatest percentage of press fluid and was thus the juiciest but, as the analysis of variance of these data (Table 20) shows, there were no significant differences either in the juiciness scores for each product or for the four test replications. These data do not agree with the sensory evaluation of this product parameter (Table 17), which did show a difference significant at the 5 percent level. The breast poached in the Gallo wine scored last in the Carver Press tests, while the sensory evaluation panel placed it first. Although the rankings were dissimilar, the only statistical difference which came out of both the mechanical and sensory testing was between the products prepared with Gallo and Sterling wines.

Shear Press--Results of the Shear Press test for tenderness, mean lb. force/gm. from the four replications and

the standard deviations for each sample, are presented in Table 21. The product prepared with Holland House cooking wine ranked first, as it was in the Carver Press results. The three products poached in wine all ranked ahead of the one made in stock, but none of the scores were statistically dissimilar, as is shown by the analysis of variance in Table 22. There were no significant differences among either the sample scores or the four test replications. Here again, there was lack of agreement between the objective and sensory evaluations. The taste panel (Table 17) found a difference, significant at the 5 percent level of probability, between the Gallo-poached breast and the control, the product prepared without wine. This is hardly conclusive, but could be due to the tenderizing properties of wine. On the other hand, there was no statistical variance among the other two wine-prepared breasts and the one made in stock. The hypothesis of no difference among products prepared with different wines was supported by the results of both the Carver and Shear Press measurements.

Sauce: Poached Breast of Chicken

The sauce was included as a sensory evaluation variable because it was a simple matter to thicken the poaching liquid with a roux and enrichen it with a liaison made from egg yolk and cream. Since the poaching liquid was 50 percent

Table 22. Analysis of variance of data from Shear Press testing of poached chicken breast.

Source of Variation	DF	SS	MS	F Value
Replications	3	65.74	21.91	2.44
Samples	3	13.02	4.34	.48
Error	9	80.80	8.98	

wine, it was theorized that quality differences between the wines would perhaps be even more apparent in a sauce form than in the cooked chicken meat.

Sensory Evaluation

In evaluation of the sauces, only the palatability factors of aroma, flavor, and color were used, since the criteria of tenderness and juiciness could not be applied to a liquid product. Table 23 shows the mean scores assigned by the judges over the six taste panel sessions and the standard deviations of those scores. In both of the two quality characteristics most likely to be modified by addition of wine and by variance of the wines, aroma and flavor, the wine-prepared products were ranked ahead of the stock-based sauce and, in both cases, the premium wine, Sterling, was the highest ranked. With the color quality attribute, the rankings were reversed, and the sauce made with Sterling wine ranked lowest, while the one made entirely with stock was second.

Table 24 gives the analyses of variance of the data in Table 23. There were, as with the scores from the poached breasts, differences among the judges which were significant at the .1 percent level of probability but, as with the breasts, they were the result of judges using different point values, not because they were discerning any differences

Table 23. Mean scores[a] and standard deviations for sensory evaluation of quality characteristics of poached breast of chicken sauce.

Sensory Characteristic	Prepared With	$\bar{X}$ Score	Standard Deviation
Aroma	Sterling	8.53	2.67
	Gallo	7.63	2.97
	Holland House	7.51	2.48
	No wine (control)	7.27	2.65
Flavor	Sterling	9.14	1.63
	Holland House	8.95	2.47
	Gallo	8.94	1.74
	No wine (control)	7.55	2.11
Color	Gallo	10.14	1.98
	No wine (control)	9.98	1.93
	Holland House	9.95	2.24
	Sterling	9.60	2.28

[a]A thirteen-point hedonic scale was used for sensory evaluation with 13 being the highest score. See Appendix 5 for the score card.

Table 24. Analyses of variance for taste panel palatability factors for poached chicken breast sauce.

Source		F Values		
	DF	Aroma	Flavor	Color
Judges	9	20.87***	4.95***	38.36***
Products	3	2.48	2.66	1.20

***Significant at the .1 percent level of probability.

among products. The analysis of variance of the products' quality criteria showed the following:

Aroma--There were no significant differences among any of the sauces prepared with wine nor were there any variances between wine-prepared sauces and the sauce prepared entirely from stock. Although the highest mean score was given to the premium wine, Sterling Vineyards, and the lowest to the control, there was no statistically meaningful difference.

Flavor--Here, also, the highest mean score was assigned to the Sterling Vineyards sauce and the lowest to the control, but, statistically, there were no differences among the scores, either among the three wine-prepared samples or between the wine and stock-based products.

Color--The mean scores were nearly identical and no statistical variances were reported.

The hypothesis of no difference among products prepared with different wines was supported by the data from a poaching liquid composed of 50 percent wine.

Braised Thigh of Chicken in Red Wine

The chicken thighs were chosen since they afforded an opportunity to test the effects of red wine upon the mild flavors of chicken, and because one of the classic

preparations in the French Provincial cuisine repertoire is Coq-au-vin, chicken braised in red wine.

Sensory Evaluation

Mean scores and standard deviations of the sensory evaluation of chicken thighs braised in three different red wines and one prepared without wine are given in Table 25. With the aroma factor, the standard deviations indicate a broader range of scores than is the case with the quality criteria of tenderness, juiciness, flavor, and color which show a greater degree of agreement on the relative rankings.

The mean scores show that the thighs braised in either the premium wine, Carneros Creek, or the cooking wine, Holland House, ranked first in all five characteristics, although the cooking wine product was also assigned the bottom ranking in two areas. This could indicate some ambivalence on the part of the sensory panel in evaluating the quality characteristics of foods prepared in this type of wine, but these (tenderness and juiciness) are the two factors least likely to be affected by quality or type of wine. The results of the three remaining sensory characteristics, aroma, flavor, and color, show that the three wine-prepared samples were preferred to those braised in stock. The other wine, Foppiano, made a product which was rather consistently ranked third (four out of the five with one second).

Table 25. Mean scores[a] and standard deviations for sensory evaluation of quality characteristics of chicken thigh braised in three different red wines and for one sample prepared without wine.

Sensory Characteristic	Prepared	$\bar{X}$ Score	Standard Deviation
Aroma	Holland House[1]	9.63	1.93
	Carneros Creek[1]	9.37	2.53
	Foppiano[1]	9.18	2.22
	No wine (control)	6.99	2.68
Tenderness[b]	Carneros Creek	11.10	1.16
	No wine (control)	10.86	1.68
	Foppiano	10.78	1.73
	Holland House	10.60	1.52
Juiciness[b]	Carneros Creek	10.16	1.42
	Foppiano	10.03	1.31
	No wine (control)	9.97	1.41
	Holland House	9.64	1.60
Flavor	Carneros Creek[2]	10.08	1.05
	Holland House[2]	10.04	1.08
	Foppiano[2]	9.76	1.20
	No wine (control)	9.03	1.42
Color[b]	Holland House	10.37	1.61
	Carneros Creek	10.04	1.34
	Foppiano	9.92	1.87
	No wine (control)	9.73	1.54

[a]A thirteen-point hedonic scale was used for sensory evaluation with 13 being the highest score. See Appendix 5 for the score card.

[b]There are no significant differences among samples.

[1]There are no significant differences among these products at the .1 percent level of probability.

[2]There are no significant differences among these products at the 1 percent level of probability.

The results of the analyses of variance of the data in Table 25 are shown in Table 26. As was the case with the poached breasts and sauces, there were very significant differences between the scoring scales used by the various judges (significant at the .1 percent level), but these were not considered to have any effect upon the testing of product variation. The scores of the palatability criteria of tenderness, juiciness, and color showed no variance, while those of aroma and flavor were statistically dissimilar.

Aroma showed a very significant variance of .1 percent and flavor a variance at the 1 percent level. The sensory evaluation scores for tenderness and juiciness were in agreement with the objective measurements, which also failed to find any significant differences among the four samples. The results of the color evaluation were somewhat surprising since there would be expected to be color differences between chickens braised with red wines and those braised with stock. The control product (no wine) did have the lowest mean sensory score, but the difference was not statistically significant.

Multiple-range tests were applied to the data from aroma and flavor to determine which specific products differed; the subscripts in Table 25 give the results. There were no significant aroma differences among the three products prepared with wine, but all were judged significantly

Table 26. Analyses of variance for taste panel palatability factors for braised chicken thigh.

Source	DF	F Values				
		Aroma	Tenderness	Juiciness	Flavor	Color
Judges	10	8.23***	9.97***	10.77***	6.75***	13.47***
Products	3	8.18***	.65	.90	6.47**	1.30

**Significant at the 1 percent level of probability.
***Significant at the .1 percent level of probability.

different (at the .1 percent level of probability) from the product prepared with stock, and preferable to that product. The multiple-range test on flavor yielded nearly identical data. There was no real variance among the mean scores of the three wine-prepared thighs, and all were preferred to the control. The preference was at the 1 percent level. Here the thighs made with cooking wine were ranked second rather than first, as was the case with aroma, but in both cases the preferences were not statistically significant.

The hypothesis of no difference among products was supported in the case of chicken thighs braised in red wine. The only difference of importance from a statistical standpoint was between wine-braised and stock-braised chicken and, then, only with aroma and flavor, not with tenderness, juiciness, or color. Comparison of only the wine-prepared samples showed no difference with any of the five palatability factors.

Objective Measurement

The cooked thighs were measured quantitatively for juiciness by the Carver Press and for tenderness by the Shear Press.

Table 19 gives the results from the Carver Press measurements, and Table 27, the analysis of variance of these data, shows that there were no significant differences, either among the replications or the samples. Tables 21 and 28 are

Table 27. Analysis of variance of data from Carver Press testing of braised chicken thigh.

Source of Variation	DF	SS	MS	F Value
Replications	3	13.14	4.38	.189
Samples	3	27.52	9.17	.396
Error	9	208.43	23.16	

Table 28. Analysis of variance of data from Shear Press testing of braised chicken thigh.

Source of Variation	DF	SS	MS	F Value
Replications	3	9.51	3.17	2.06
Samples	3	4.35	1.45	.942
Error	9	13.85	1.54	

the data and analysis of variance respectively of the Shear Press testing for tenderness. There were no significant differences in replications or samples. In other words, varying the wine type and quality had no real effect upon either the juiciness or tenderness, as measured on braised chicken thighs. In fact, it made no difference whether they were cooked with wine or stock.

The hypothesis of no difference among products prepared in different wines was supported by both the Carver and Shear Press measurements.

Sauce: Braised Thigh of Chicken

The sauce, which is an integral part of the braised thigh preparation, was evaluated separately so that the thigh flesh could be tested independently as was done with the breast. Tasting the meat with the sauce would add flavors, aromas, and textures which would make an objective analysis of the sensory characteristics of the chicken difficult. It was also considered desirable to evaluate the sauce, since, in the cases of the three wine-prepared samples, the only liquid used in the braising was wine. It was felt that the slow, extended cooking would afford a good opportunity to study flavor, aroma, and color modifications in the various wines used.

Sensory Evaluation

Table 29 gives the mean scores and standard deviations for the taste panel's evaluation of the braised thigh sauce. With the two most important sensory characteristics (aroma and flavor), the thighs prepared in stock (control) were ranked last and the standard deviations for both were considerably higher than were those of the samples braised in wine. In both of these sensory factors, the thighs prepared either in premium wine (Carneros Creek), or the cooking wine (Holland House), ranked first or second. The third sample, thighs made in Foppiano, the so-called "standard" wine, ranked a consistent third with regard to aroma and flavor. With the color factor, Foppiano-braised thighs ranked fourth, being ranked slightly behind the one made with no wine at all. This could possibly indicate some instability on the part of the color compounds in this wine. They may have been lost, or altered to a greater degree than were those in the other two wines.

The analyses of variance of the data in Table 29 is shown in Table 30.

Aroma--A difference, significant at the 1 percent level of probability, was found. The multiple-range test was applied to the data in order to determine which samples were in variance with the others. This information is given in the subscripts in Table 29. There was no difference between the thighs made with Carneros Creek or Holland House nor was

Table 29. Mean scores[a] and standard deviations for sensory evaluation of sauce from chicken thigh braised in three different red wines and for one sample prepared without wine.

Sensory Characteristic	Sample	Mean Score	Standard Deviation
Aroma	Carneros Creek[1]	10.24	1.45
	Holland House[1,2]	9.19	1.92
	Foppiano[2]	8.65	1.99
	Control (no wine)[2]	8.04	2.50
Flavor	Holland House[3]	10.73	1.85
	Carneros Creek[3,4]	10.09	1.73
	Foppiano[4]	9.83	1.88
	Control (no wine)[4]	8.74	2.27
Color[b]	Holland House	10.71	1.32
	Carneros Creek	10.57	1.60
	Control (no wine)	10.26	1.64
	Foppiano	10.21	1.63

[a]A thirteen-point hedonic scale was used for sensory evaluation with 13 being the highest score. See Appendix 5 for the score card.

[b]There are no significant differences among samples.

[1,2]There is no significant difference between these products at the 1 percent level of probability.

[3,4]There is no significant difference between these products at the 5 percent level of probability.

Table 30. Analyses of variance for taste panel palatability factors for braised chicken thigh sauce.

Source	DF	F Values		
		Aroma	Flavor	Color
Judges	1	4.89***	4.14**	8.04***
Products	3	4.75**	3.25*	.73

*Significant at the 5 percent level of probability.
**Significant at the 1 percent level of probability.
***Significant at the .1 percent level of probability.
[1]Sauce, color DF = 10; flavor DF = 9.

there any difference among the mean scores of products made with Holland House, Foppiano, or the control (made with stock). The Carneros Creek-prepared sample scored higher than both the ones made with Foppiano and no wine. The Holland House sample showed no statistical variance with any of the other three.

Flavor--Analysis of variance of the mean scores showed a significant variance at the 5 percent level of probability. The multiple-range test results are shown by the subscripts in Table 29. The three sauces prepared with wine were not different from each other, although only the one made with Holland House cooking wine was judged to be statistically superior to the control.

Color--There were no differences among the mean scores. The hypothesis of no difference among products prepared with different wines was supported only by the color data; the judges did perceive differences in aroma and flavor. In the cases of aroma and flavor, the product prepared without wine was scored the lowest, but with the aroma parameter it was statistically inferior to only the Carneros Creek, the premium wine, and with the flavor quality factor, it was statistically inferior only to the Holland House, the cooking wine. Closer examination of the flavor data shows that there were no differences among the wine-prepared samples, which does support the hypothesis. The aroma data show that the sample braised

in the cooking wine is not different from those made in the other two wines, although they are different from each other.

Discussion of Results

One of the most interesting results of these tests was that, in some cases, it not only did not matter which wine was used, but neither did it matter whether wine was or was not used. This was brought out in the results of the study using poached breasts. The quality factors most closely related to the quality of wine, as an ingredient, would be the way the product smelled, tasted, and looked; in other words, its' aroma, flavor, and color. With the breasts, the poaching medium seemed to have no effect upon these parameters; regardless of whether they were poached in a table wine, cooking wine, or stock. It may be that, during the relatively quick cooking period (20 minutes), there is little penetration of the poaching liquid into the breast and, therefore, it does not matter what the poaching liquid consists of. The 20-minute cooking period could have been reduced if the breasts had been tempered to ambient temperature prior to cooking, for they were cooked immediately upon being removed from refrigeration. The actual cooking time was therefore not very long and perhaps a very strong flavoring liquid would have been necessary to attain penetration sufficient to alter aromas, flavors, and colors to a degree

where they could have been organoleptically detected. White wines, which have lower molecular weight components and do not contain many of the aromatic, flavor, and color components present in red wines, may not be able to alter the quality variables of the breast when used as a poaching liquid.

These results indicate that white wine has no quality advantage over stock, when used as a poaching liquid, but it does clearly have an economic disadvantage. The least expensive wine used, the Gallo Chablis Blanc, costs approximately $2.00 per bottle (750 ml), and an acceptable stock can be prepared from a food base for about $0.15 per 750 ml bottle. This is of economic significance to the food service industry, primarily service restaurants and hotels, although wine is used as a cookery ingredient by virtually all segments of the industry, including institutional operations. Food cost escalation has been a very serious problem over the past few years and food service operators are under great pressure to hold costs down so that menu price increases can be moderated. Any data indicating particular uses of wine to be unjustified or that wines' quality characteristics are not transferred to food, would have definite cost reduction potential for the industry. As Appendix 6 shows, the portion cost can range from $0.58 (no wine) to $0.96 (premium wine), a difference of 65 percent.

The data for sauces prepared from the poaching liquids were consistent with that from the breasts; no differences were found among wine sauces or between wine and stock sauces. Wine, used as a poaching liquid, was well reduced and cooked, prior to being made into a sauce. It is generally thought that a poaching liquid, by reduction in volume and extraction of components from the product being cooked, will become more flavorful and provide high quality base material for sauce making. In the case of white wine, this is not supported. Sauces, made with wine used for poaching, were not differentiated from those made with poaching stock. An unexpected finding from this study was that, in some cases, wine may have no effect upon food quality. The data make it clear that, with this specific cooking method, and with this particular product, it makes no difference whether wine is used or not.

The use of red wine, as a braising liquid, did result in thighs prepared with wine being scored higher in aroma and flavor than those made with stock. The aroma data, in particular, were somewhat surprising in that aromatics are considered to be volatile and lost in cooking, but all three wine-prepared thighs scored significantly higher than the ones braised with stock, indicating substantial retention of aromatic components. The literature generally supports concentration and retention of wine flavor and it was expected

that the wine-prepared thighs would score significantly higher than those braised in stock, and this did occur.

The color results of the thigh sensory evaluations were the most difficult to interpret. According to the literature, the color components will react negatively to heat and fade from red to tawn, or brownish hues. The data, while ranking all wine-prepared products ahead of the thighs braised in stock, indicated no statistically meaningful differences, showing that the effects upon product color from cooking with red wine are difficult to predict, and that so-called wine "quality" may not be a food quality factor.

Due to its acid content, wine is said to have a tenderizing effect when used as a marinade. It would be supposed that in cooking, especially over an extended period, that this would be the case as well, since most of the acids are fixed and would not be expected to be lost. The data are not consistent on this point. The Shear Press results, on both breasts and thighs, showed no statistical difference. In contrast to these results, the taste panel did find significant differences, but only with the poached breast; all three wine-prepared breasts were scored higher and thus more tender than the stock-poached product. The braising process would be expected to bring out the acid-induced tenderizing effect if such existed, but neither the sensory evaluations nor the objective tests indicated that any such effect took

place. The tendency of wine, per se, to tenderize tissues, either by marination or cooking is, therefore, questionable and there may well be no such consequence.

Juiciness comparisons between the breasts and thighs were not useful due to the inherent differences between the muscular tissues and between the cooking methods, but the comparisons between objective and sensory evaluations were interesting. In the case of the breasts, the sensory panel found statistical differences among the four samples, while the extractable fluid measured by the Carver Press was found to be similar. There also was a lack of agreement as to the relative ranking of the samples. In the case of the braised thighs, there was agreement between the two test methods that no significant variances existed among product scores. There was nothing in the literature which would indicate that wine would have any effect, either positive or negative, on juiciness of meat and the lack of a pattern in these data would tend to support this view.

The sauce evaluations were considered to provide information independent of the chicken products as to the effects of wine quality upon food quality. The two preparation methods contrasted, in that the poaching technique involved a less severe heat treatment and used the cooked wine to make a sauce separate from the breast. The Coq-au-vin, on the other hand, subjected the wine to a far longer

and more severe heating process, while the sauce was more closely associated with the meat product. The data indicated, in the case of aromatics, that the relatively greater heating effect of braising is offset by the higher concentrations of aromatic compounds in red wines and that wine quality may be related to food quality, since the premium wine sauce (Carneros Creek) was ranked first with a statistical advantage over the sauces prepared from the standard wine (Foppiano), and the control (no wine). This was hardly conclusive, however, for there were no significant differences between the premium wine and the cooking wine sauces. The results on the flavor variable indicated no significant variance among the wine-braised thighs and little significant differentiation between wine and stock sauces. Only one of the three, the cooking wine, was judged to produce a sauce with better flavor than that prepared with stock. The sauce color data showed no statistical difference in scoring.

The thigh and sauce data in general were in agreement with data obtained from the poached breasts: there were no quality differences in the products arising from the use of different wines. These data do not agree with that of the breast in one important respect. There does appear to be a quality justification for braising chicken with wine rather than stock. While the color scores were, surprisingly, undifferentiated, the more important quality characteristics

of aroma and flavor showed clearly that the thighs braised in wine were distinguished from, and preferred to, those braised in stock. The economic implication here is that preparation of some foods in red wine is advantageous, but the quality of the wine has little effect upon the food quality. Considering the range of wine prices, there could be a significant cost reduction potential. As Appendix 7 shows, the portion cost can range from $0.60 (Foppiano) to $0.96 (Carneros Creek), a difference of 60 percent.

The results of the consumer evaluations of lobster bisque were illustrative of several aspects of wine cookery. With regard to wine quality, there may be instances where commonly accepted "quality" is a function of price and is represented by products with very distinctive attributes which may not be widely appreciated. Sherries are a prime example. The finest Spanish sherries are regarded to be those produced by the "flor" method, which encourages the growth of a specific yeast organism during barrel maturation. As a consequence, there is considerable oxidation as well. These wines, compared to those made in the United States, are characterized by high levels of acetaldehyde, may have chemical and salty tastes, and, sometimes, even cheese odors. Many Americans find these attributes to be objectionable and, when they are transferred to foods, as the data indicated may happen, the food product becomes less desirable.

As a result, the bisque data showed very strongly that the premium sherry, the Duff Gordon Fino, did not make an acceptable flavor additive. The comparison between the standard sherry (Christian Brothers) and the cooking sherry (Virginia Dare) showed that, while the Christian Brothers was preferred, the scoring differences were not statistically meaningful. The cost comparisons (Appendix 8) showed insignificant portion cost differences between the Christian Brothers and "cooking" wine bisques, while the bisque prepared with Duff Gordon costs nearly 31 percent more to serve. Thus, the imported sherry made an unacceptable product, both from a sensory and an economic standpoint.

Another aspect brought out by the study was that wine can perform very different functions in cookery, and importance of the wine quality can vary from function to function. The lobster bisque formulation called for the wine to be used as a finish flavoring. This type of usage subjected the wine to minimal heat, for the wine was not actually heated, it was merely warmed by being mixed into a hot soup. It is also possible that a portion of the alcohol was not volatilized. It would be expected that, if wine quality were to be a factor in cookery, this type of function would demonstrate it most clearly. The data, however, showed that quality, per se, was not a factor. The poaching process showed the effect of using wine, both as a heat transfer medium and as a base material for sauces. In neither case did wine quality appear

to be a factor which influenced food quality. Braising illustrated the use of wine as an essential formulation ingredient, an ingredient which provided flavor, texture (in the form of viscosity--the sauce), and aroma. Again, the wine quality, as defined by drinking standards, was not a factor which contributed to differentiation of the foods prepared.

While the data did not indicate any causal relationship between wine quality and food quality, neither did it indicate that the "cooking" wines were inferior to table wines. A case could be made, based upon the relative ranking of the various sensory scores, that, while not statistically significant, the scores of products prepared in, or with, cooking wine were better, in many cases, than table wines. This finding would be more useful to the food service industry if cooking wines were priced at a competitive advantage relative to table wines, but the fact is that there are many wines on the market priced below the main brands of cooking wines. The cooking wines, in addition to offering little or no cost benefit, have usage restrictions as well. The one and one-half percent salt additive obviously precludes their use in most dessert preparations, from being reduced in volume by half or more, as is often called for, and there could be dietary restrictions as well.

SUMMARY AND CONCLUSIONS

The influence of quality of selected wines on the sensory characteristics of some specific foods were studied. The foods and wines used in the study were lobster bisque, flavored with dry sherries, breast of chicken, poached in white wines, and chicken thighs, braised in red wines. Sauces were prepared for each of the chicken products and evaluated to provide additional sensory data. A consumer panel, composed of persons attending dinners organized by students in the School of Hotel, Restaurant, and Institutional Management, was used for the lobster bisque evaluation. There were a total of 156 guests attending the three dinners at which the tests were conducted. Chicken breasts, thighs, and their respective sauces were evaluated by a trained panel drawn from Hotel and Restaurant seniors enrolled in an elective course on sensory perception and food evaluation. They participated in six replicate tasting sessions during the Spring term of 1978.

The lobster bisque was prepared with a convenience food base for product consistency over the three dinners. The bisque was prepared in a single batch each evening and held at a simmering temperature until the guests were seated, whereupon it was divided into three equal parts, each of which

was flavored with a sherry. The wines used were: Christian Brothers Dry Cocktail Sherry, Virginia Dare Cooking Sherry, and Duff Gordon Fino Sherry (Spanish imported wine). Each of the three was portioned (45 ml) into small tasting cups and sent into the dining room to be evaluated. The persons participating in the study were given scoring sheets when they entered and, after being seated, were given detailed instructions on its use.

A demographic survey was included, which enabled analysis of the results by age and sex, as well as the total population.

The chicken breasts were boned prior to poaching, and then cooked in a liquid consisting either entirely of stock, or of a stock/white wine mixture in a 1:1 ratio. The wines used were Holland House white cooking wine, Gallo Chablis Blanc (the "standard" table wine), and Sterling Vineyards 1976 Chenin Blanc (the "premium" table wine). When the breasts were fully cooked (71°C - 160°F) they were removed from the simmering liquid and cut into portions for sensory evaluation and for mechanical testing. The portions intended for testing by the Carver Press (juiciness) and the Allo-Kramer Shear Press (tenderness) were wrapped in foil and frozen. The portions intended for sensory evaluation were held in a hot water bath (80°C - 176°F).

The thighs were prepared for braising by browning in a saute pan with mushrooms and onions. All ingredients were then placed in a sauce pan with wine or stock (the control--no wine). The three wines used were Holland House red cooking wine, Foppiano Zinfandel (the "standard" table wine), and Carneros Creek 1975 Zinfandel (the "premium" table wine). The liquid was brought to a boil, the pans were covered, and the heat was lowered. The thighs were cooked for approximately 40 minutes or to an internal temperature of 94°C (201°F). They were removed from the pans and de-boned and de-skinned and cut into portions for sensory evaluation and mechanical testing. The portions intended for mechanical testing were wrapped in foil and frozen. The portions intended for sensory evaluation were returned to the pan (with their sauces) and held in a hot water bath.

The poached breast sauce had to be prepared separate from the breast while that for the braised thighs did not, since the braising process produced its own sauce. Preparation of the breast sauce was done by thickening the poaching liquid with a roux (butter and flour cooked together) and enrichening it with a liaison made of egg yolks and light cream. The breast sauce was also held in the hot water bath.

The lobster bisque results showed that there was no difference between products flavored with the cooking wine or the standard quality wine, while both were preferred to the

bisque flavored with the premium sherry. These results were consistent with all segments of the population (male, female, under-25-years of age, over-25-years of age), as well as the total population. The data from the male and under-25-years population differed slightly from the others in that they found no significant difference between the cooking wine and the premium wine-flavored bisques. In both of these cases, however, the overall ranking was the same as with all other population segments.

The chicken breasts were evaluated for aroma, flavor, color, juiciness, and tenderness. It was found that the quality factors of aroma, flavor, and color were not significantly affected by the wine used. In addition, it was found that there were no significant aroma, flavor, or color differences between breasts poached in wine and those poached in stock. The tenderness results showed that the three wine-prepared samples were not scored significantly different from each other, nor, with the exception of the Gallo-poached breast, were there any differences between breasts prepared in wine or in stock. Only with the juiciness characteristic were there any statistical variances in scores; the results showed that the standard wine (Gallo) produced a product which scored higher than that made in premium wine (Sterling Vineyards). The objective measurements did not agree with the sensory data since no differences in tenderness (lb. force/g) were found,

either among breasts made with wine or between wine and non-wine poached breasts.

The same sensory characteristics were used in the evaluation of the braised thighs. Comparison of the data from thighs prepared in the three wines showed no difference in the scores of any of the five palatability factors. The only differences of importance, from a statistical standpoint, were those between wine-braised and stock-braised chicken, but they were with the important sensory factors of aroma and flavor. There were no differences with the characteristics of tenderness, juiciness, or color. The mechanical results were similar to those of the breasts; there were no differences of any kind, either with tenderness or juiciness.

The sauces were evaluated for the sensory characteristics of aroma, flavor, and color. With the sauces prepared from the breast poaching liquids, there were no differences, either among the wine-based sauces or between the wine-based sauces and the one made entirely from stock. The braised thigh sauces yielded inconsistent data. Only the data from the evaluation of color supported the hypothesis of no difference among products prepared with different wines or with stock. The results from the evaluation of sauce aroma indicated that the sauce made with premium wine (Carneros Creek Zinfandel) was superior to the standard wine sauce (Foppiano), but was the same, statistically, as the cooking wine sauce (Holland

House). The sauce prepared from chicken braised in stock was scored similar to those made with the standard and cooking wines. Evaluation of the sauces' flavor characteristics showed no differences among wine sauces, although only the cooking wine produced a sauce judged to be statistically superior to the control (no wine).

It would appear, from these results, that the traditional views on wines in cooking are questionable. In some areas there was clearly no positive relationship between wine quality and food quality. The use of white wine as a poaching liquid would fall into this category. White wines are light and delicate with less odor, flavor, and color components (relative to red wines), and whatever heat induced degradation of these components occurred appeared to do so more readily with white wines. The wine characteristics, when combined with the characteristics of the poaching method, resulted in no differentiation among wines or between poaching in wine or stock, nor were there any differences in the sauces made from each poaching liquid. Therefore, not only is the use of premium wines questionable in this case, but the use of wine at all is also questionable, for it would seem that stock serves equally well.

In the case of the lobster bisque, the sherry wine was used as a final flavoring ingredient. The time and temperature parameters were minimal and it was thought that the

chances of odor, flavor, and color retention would be somewhat improved and that if wine quality were a factor, it would be more likely with this product than with the others. Two conclusions seem valid from the data; one being that, between standard and cooking sherries, wine quality has little effect upon finished bisque quality, the other is that imported sherries, particularly the Flor type, may be objectionable in cooking due to their high acetaldehyde content, chemical and salty tastes, and cheese odors. These results clearly indicate that drinking quality cannot necessarily be equated with cooking quality.

The use of wine, particularly red wine, as a braising liquid presents a very different situation relative to the previous two. In this case, the time and temperature parameters are increased significantly. The presence of other ingredients, including lipid materials, with the chickens as well as the closed container (resulting in steam retention), means that higher cooking temperatures will likely be attained. The cooking time will also be longer. The wine, rather than performing the function of a medium of heat transfer, as with the poached breast, or as a finishing flavor, as with the bisque, is an essential basic flavor ingredient and provides texture in the form of viscosity of the sauce. The stronger flavors, odors, and colors of the wine must be considered also. The conclusion here is that if wine quality has an

effect upon food quality, it most likely would occur under these conditions, but the differences which resulted were marginal. In these tests, there were no differences among wine-prepared thighs but they were differentiated from, and preferred to, those thighs prepared with stock. Therefore, unlike poaching breasts in white wine, braising with red wine does appear to improve the product and to be a worthwhile process.

SUGGESTIONS FOR FURTHER RESEARCH

Although conclusions have been drawn in this study which appear valid for the wine types and specific foods used, additional research in the following areas is suggested:

1--Chemical analyses and sensory evaluations should be performed on wines in their natural state, and then following moderate heating, and finally after prolonged heating. There obviously are degradative changes in the wine which occur upon heating, and if it were known which wine flavor and odor components best survive heating and have potentially positive influences upon food quality, it may be possible to prepare wine flavor extracts for use in food preparation, rather than wines themselves.

2--What, if any, changes in tenderness occur when foods are either marinated in wines or cooked in wines? This study tended to indicate that no tenderness benefits occur from cooking chicken in red or white wines, but testing of beef and other meats could yield different results. The literature contains many references to such an effect, but they are supported by little research data.

3--Additional sensory evaluations could be made to determine whether other foods, such as seafood and beef, would show results similar to those obtained with chicken.

4--The influence of the native American grape vine, the Vitis labrusca, upon the sensory evaluation of foods could be measured. The wines from this vine species are dramatically different from those from Vitis vinifera which were used in this study and cooking results may not be the same.

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APPENDICES

Appendix 1. 4-Sample, 3-Replication, Balanced Block Design

Judge	REPLICATIONS			
	Order of Presentation	Order of Presentation	Order of Presentation	Order of Presentation
1	4 3 1 2	3 2 4 1	2 1 3 4	1 4 2 3
2	2 1 3 4	1 4 2 3	4 3 1 2	3 2 4 1
3	1 2 3 4	2 3 1 4	3 4 2 1	4 1 3 2
4	3 4 2 1	4 1 3 2	1 2 4 3	2 3 1 4
5	4 1 2 3	1 3 4 2	3 2 1 4	2 4 3 1
6	3 2 1 4	2 4 3 1	4 1 2 3	1 3 4 2
7	4 2 3 1	2 1 4 3	1 3 2 4	3 4 1 2
8	1 3 2 4	3 4 1 2	4 2 3 1	2 1 4 3
9	2 3 4 1	3 1 2 4	1 4 3 2	4 2 1 3
10	1 4 3 2	4 2 1 3	2 3 4 1	3 1 2 4
11	2 4 1 3	1 2 3 4	3 1 4 2	4 3 2 1
12	3 1 4 2	4 3 2 1	2 4 1 3	1 2 3 4

Source: Sidel and Stone, 1976.

Appendix 2. Typical order of presentation of four breast and four thigh samples (with their sauces).

	White	Red
Jack K.	53-30-37-35	57-61-41-93
Donna B.	30-35-53-37	61-93-57-41
Ron E.	37-53-35-30	41-57-93-41
Ingolf N.	35-37-30-53	93-41-61-57
Nancy J.	35-53-37-30	93-57-41-61
Jeanie O.	53-30-35-37	57-61-93-41
Julie O.	37-35-30-53	41-93-61-57
Ric M.	30-37-53-35	61-41-57-93
Tom F.	37-35-53-30	41-93-57-61
Bob S.	35-30-37-53	93-61-41-57
Robb S.	53-37-30-35	57-41-61-93
Rob M.	30-53-35-37	61-57-93-41
Steve D.	30-37-35-53	61-41-93-57
Barb F.	37-53-30-35	41-57-61-93
Jack B.	35-30-53-37	93-61-57-41
Dan C.	53-35-37-30	57-93-41-61
Dave K.	35-53-30-37	93-57-61-41
Tom B.	53-37-35-30	57-41-93-61
Tom P.	30-35-37-53	61-93-41-57

Appendix 3. Lobster bisque score card.

Instructions

You will be given three servings of Lobster Bisque to eat, and you are asked to say about each how much you like it or dislike it.

Use the scales below to indicate your attitude. Note the code number of each sample and check the point on the scale which best describes your feeling about the food. Your comments are invited. They are generally very meaningful.

There are no right or wrong answers, as you are the only one who can tell what you like.

_____ like extremely	_____ like extremely	_____ like extremely
_____ like very much	_____ like very much	_____ like very much
_____ like moderately	_____ like moderately	_____ like moderately
_____ like slightly	_____ like slightly	_____ like slightly
_____ neither like nor dislike	_____ neither like nor dislike	_____ neither like nor dislike
_____ dislike slightly	_____ dislike slightly	_____ dislike slightly
_____ dislike moderately	_____ dislike moderately	_____ dislike moderately
_____ dislike very much	_____ dislike very much	_____ dislike very much
_____ dislike extremely	_____ dislike extremely	_____ dislike extremely
Comments	Comments	Comments

Appendix 4. Lobster bisque consumer panel demographic survey.

In order to evaluate this data, we need some information. Would you please check the appropriate boxes.

1. Sex: Male_____ Female_____

2. Age: Under 25_____
   25-35 _____
   35-45 _____
   45-55 _____
   55-65 _____
   Over 65 _____

3. Income Range: Under $10,000 _____
   $10,000-$15,000_____
   $15,000-$20,000_____
   $20,000-$30,000_____
   Over $30,000 _____

4. Have you eaten Lobster Bisque enough times to be familiar with how it tastes and smells?

   Yes_____ No_____

5. This Lobster Bisque was prepared with wine. We want to know how often you eat foods prepared with wine.

   Very often_____
   Sometimes _____
   Seldom _____
   Never _____

6. How often do you serve wine with your meals (both at home and away from home)?

   Very often_____
   Sometimes _____
   Seldom _____
   Never _____

Apeendix 5. Chicken breast, thigh, and sauce score sheet.

Name_____ Chicken Sample #_____ Date_____

Aroma	Tenderness	Juiciness	Flavor	Color
___Very Pronounced	___Very Tender	___Very Juicy	___Very Desirable	___Very Desirable
___	___	___	___	___
___Moderately Pronounced	___Moderately Tender	___Moderately Juicy	___Moderately Desirable	___Moderately Desirable
___	___	___	___	___
___Slightly Prounounced	___Slightly Tender	___Slightly Juicy	___Slightly Desirable	___Slightly Desirable
___	___	___	___	___
___Perceptible	___Neutral	___Neutral	___Neutral	___Neutral
___	___	___	___	___
___Modeaately Perceptible	___Slightly Tough	___Slightly Dry	___Slightly Undesirable	___Slightly Undesirable
___	___	___	___	___
___Slightly Perceptible	___Moderately Touch	___Moderately Dry	___Moderately Undesirable	___Moderately Undesirable
___	___	___	___	___
___Imperceptible	___Very Tough	___Very Dry	___Very Undesirable	___Very Undesirable

Appendix 6. Cost comparisons among chicken breasts poached in three different white wines and one in stock and the sauces made from the poaching liquids.

Cost of basic or common ingredients:

Chicken breast (boned)	12.5 lb. @	$2.00/lb.	$25.00
Butter	9.6 oz. @	1.50/lb.	1.50
Flour	9.6 oz. @	.15/lb.	.09
Egg	1.0 dz. @	1.00/dz.	1.00
Half-and-half	25.0 oz. @	.75/qt.	.60
Total for 50 portions			$27.59

Individual product cost:

	Holland House	Gallo	Sterling Vineyards	No wine (Control)
Wine cost	$10.63	$ 7.97	$19.92	$00.00
Stock cost	.60	.60	.60	1.20
Basic cost	27.59	27.59	27.59	27.59
Total cost	$38.82	$36.13	$48.11	$28.79
Cost per portion	$ 0.78	$ 0.72	$ 0.96	$ 0.58

Appendix 7. Cost comparisons among chicken thighs braised in three different red wines and one in stock, and their sauces.

Cost of basic or common ingredients:

Chicken thighs	17.00 lb. @	$1.00/lb.	$17.00
Butter	.37 lb. @	1.50/lb.	.56
Bacon	22.00 oz. @	1.50/lb.	2.05
Mushrooms	2.00 lb. @	1.00/lb.	2.00
Onions	3.00 lb. @	.15/lb.	.45
Shallots	.75 lb. @	1.00/lb.	.75
Garlic cloves	5.00 ea. @	.02/ea.	.10
Flour	.40 lb. @	.15/lb.	.06
Faggot	1.00 ea. @	.50/ea.	.50
Total for 50 portions			$23.47

Individual product cost:

	Holland House	Foppiano	Carneros Creek	No wine (Control)
Wine or stock cost	$11.04	$ 6.36	$24.38	$ 1.27
Basic cost	23.47	23.47	23.47	23.47
Total cost	$34.51	$29.83	$47.85	$24.74
Cost per portion	$ 0.69	$ 0.60	$ 0.96	$ 0.49

Appendix 8. Cost comparisons among lobster bisques prepared with three different sherry wines.

Cost of basic or common ingredients:

Butter	1.0 lb. @ $1.50/lb.	$1.50
Flour	1.0 lb. @ .15/lb.	.15
Lobster base	0.5 lb. @ 6.50/lb.	3.25
Half-and-half	1.0 qt. @ .75/qt.	.75
Brandy	4.0 oz. @ .22/oz.	.88
Total for 50 portions		$6.53

Individual product cost:

	Christian Brothers	Virginia Dare	Duff Gordon
Wine cost	$2.75	$3.00	$ 6.00
Basic cost	6.53	6.53	6.53
Total cost	$9.28	$9.53	$12.53
Cost per portion	$0.1856	$0.1906	$0.2506