RESEARCH AND PROFESSIONAL BRIEFS

Alcohol retention in food preparation

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There has been an increased interest in the use of wines, liqueurs, and distilled spirits in preparing main dishes, sauces, and desserts. Alcoholic ingredients fulfill the needs of "nouvelle" and "light" cuisines as substitutes for heavy creams and starches, and they provide new and interesting flavors.

Because of the low boiling point of alcohol (ethanol) relative to water (78.5°C vs 100°C), alcohol has generally been assumed to evaporate from foods during cooking. This hypothesis has not, however, been validated by actual experimentation. Also, no information is available about food preparation with alcoholic ingredients that involves no heat application or that involves temperatures below the boiling point of alcohol.

We conducted this study to document the extent of alcohol lost in food preparation. Six recipes were selected to examine alcohol loss due to various methods of preparation. The preparation methods included applying no heat and refrigerating overnight, adding alcohol to a hot sauce, flaming, oven baking, simmering for a short time, and simmering for a long time.

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Alcohol retention data are important to dietitians when they calculate the alcoholic and energy content for prepared food items, because alcohol contributes 6.93 kcal/g of alcohol (1). Alcohol's presence in significant amounts affects the energy value of a food. Our study was designed to determine alcohol retention for the National Nutrient Data Bank.

MATERIALS AND METHODS

Six recipes were selected for this study (Table 1). The basis for their selection was varied exposure to heat treatment, as outlined in Table 1. The recipes, including preparation with minor modifications, were those of the *Pillsbury Kitchens' Cookbook* (2). All recipes were prepared in duplicate.

All samples intended for analysis were ground and/or homogenized. Subsamples were then removed without further treatment for moisture determination. A second set of subsamples was diluted with appropriate amounts of all-glass–distilled, chilled water and were homogenized using a Polytron (Brinkman Instruments, Westbury, NY) for 2 minutes at high speed. The slurry was then centrifuged (International Equipment Co, Needham Heights, Mass) in capped tubes for 10 minutes at 2,500 rpm. The supernatant was used for the alcohol determination.

Moisture was determined gravimetrically using overnight vacuum drying at 70°C. To determine alcohol content, the gas-liquid chromatography technique described by Martin et al (3) with 2-propanol as the internal standard was used. Retention of alcohol in the recipes during their preparation was calculated

and reported as true retention values according to the method of Murphy et al (4).

RESULTS AND DISCUSSION

Table 1 summarizes the sources of alcohol used, the type and times of heat applied, the alcohol content of the recipes before and after cooking, and the associated or calculated retention values.

Alcohol retention ranged between 4% and 85%. We believe the differences are associated with the degree of severity of heat treatment. However, the mean retention value of alcohol in the orange chicken burgundy, which involved 10 minutes of simmering at 85°C, was only slightly lower than that of the scalloped oysters baked at 191°C for 25 minutes. One possible explanation for the slightly higher retention values of the oyster samples could be the relatively low rate of heat transfer in dry heat systems such as oven baking in comparison to the much more efficient rate in wet heat systems such as simmering. What might also help explain this phenomenon is that during the preparation of the orange chicken burgundy, the alcohol was added to the product while it was boiling; in the case of the scalloped oysters, the alcohol was added to a relatively low-temperature product, that is, after the margarine was melted and the unheated oysters and some of the bread crumbs were added. Moreover, half of the bread crumbs were added to the product last and immediately before oven baking. These bread crumbs could act as a deterrent to alcohol evaporation.

Initially, large differences in the final alcohol content were found between the two replicate sums of the orange chicken burgundy samples. A subsequent rerun of the product revealed identical tendencies. Further investigations into the matter showed a slight difference in size between the two pans used for the replicate samples, that is, 12-in vs 10-in diameter, resulting in respective surface areas of 113 and 79 sq in. As Table 1 shows, the lower alcohol values of the finished product are associated with the samples cooked in the 12-in diameter pan—the pan with the greater surface area. In other words, the larger the surface area, the more alcohol evaporates during cooking. This effect is enhanced inversely by the length of the cooking time, as evidenced by the relative alcohol content in the pot roast Milano vs the orange chicken burgundy. Although differences in the moisture content followed the same trend as those of alcohol, they were far from being of a magnitude that could explain the difference in alcohol values. This becomes evident when computing the alcohol values on a dry weight basis, which averaged 0.156% and 1.048% for the samples cooked in the 12-in and 10-in diameter pans, respectively, in the case of the orange chicken burgundy and 0.212% and 0.325% in the respective pan sizes with pot roast Milano.

With the exception of the flaming recipe, cherries jubilee, the alcohol loss of all recipes can be attributed to evaporation during cooking or, as was the case with the brandy alexander pie, to evaporation during refrigeration overnight in an uncovered container. Thus, the extent of the conditions favorable to evaporation largely determine the loss of alcohol. With the flaming dish, alcohol loss is primarily the result of alcohol combustion. The alcohol continues to burn as long as minimum alcohol vapor pressure is maintained. Once this vapor pressure is reduced below a certain point, the alcohol ceases to burn, which happens during flaming and thus accounts for the relatively high retention of alcohol during the process. In terms of absolute amounts of alcohol in comparison with alcoholic beverages, alcohol values were significantly lower in the recipes used in this study (Table 2). The alcohol content of recipes that involve any length of heating are a fraction of the alcohol content of alcoholic beverages.

Table 1
Alcohol retention of selected recipes

	Pot roast Milano	Orange chicken burgundy	Scalloped oysters	Brandy alexander pie	Cherries jubilee	Grand Marnier sauce
Source of alcohol	Burgundy	Burgundy	Dry sherry	Brandy and Creme de Cocoa	Brandy	Grand Marnier
Source of heat	Simmer, 85°C (185°F)	Simmer, 85°C (185°F)	Baked, 191°C (375°F)	. . .	Flamed	Added to boiling hot sauce (195°F)
Length of heating after alcohol added	2½ hr	10 min	25 min	. . .	48 sec	. . .
Theoretical weight % alcohol before cooking	1.22-1.24	0.58-0.62	1.89-1.94	2.35-2.40	2.87-3.06	4.38-4.54
Weight % alcohol before cooking	. . .	. . .	2.59-3.02	2.08-2.12	. . .	. . .
Analyzed % alcohol after cooking	12-in pan: 0.06-0.10 10-in pan: 0.11-0.12	12-in pan: 0.07 10-in pan: 0.39-0.46	0.93-1.08	1.77-1.88	2.29-2.48	4.02-4.21
True retention	4%-6%	10%-60%	41%-49%	70%-77%	77%-78%	83%-85%

Table 2
Alcohol consumption per serving

Recipe	Size of serving	Weight of serving	Alcohol per serving
			g
Pot roast Milano	⅛ recipe	168	0.2
Orange chicken burgundy	⅙ recipe	196	0.6
	⅙ recipe	147	0.4
Scalloped oysters	¼ recipe	108	1
Brandy alexander pie	⅛ pie	153	3
	⅙ pie	115	2
Cherries jubilee	⅙ recipe	87	2
Grand Marnier sauce	2 Tbsp	26	1
Regular beer (ref 5)	12 fl oz	356	12.8
Wine (ref 5)	3.5 fl oz	103	9.3
Distilled spirits (90 proof) (ref 5)	1.5 fl oz	42	15.9

CONCLUSION

The assumption that all alcohol is evaporated when heat is applied during cooking is not valid. Six alcohol-containing recipes in this study retained from 4% to 85% of the alcohol.

Cooking always results in some, but not total, loss of alcohol. The extent of loss depends on the severity of the heat application or any other factor favoring evaporation. Flaming results in much smaller losses of alcohol than cooking. Alcohol retention during cooking can also be greatly affected by the type of cooking vessel used, especially when short cooking times are involved. ■

References

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