which pyridine might be released is by substitution with an olefin molecule.

$$Cl_2Pd\ \text{pyridine(P-PS)} + R_2\text{-CH} = \text{CH-}R_1 \rightarrow Cl_2Pd(R_2\text{-CH} = \text{CH-}R_1)\ \text{(P-PS)} + \text{pyridine}$$

Because of the color change noted during the activation, none of the proposed substitution products are likely to be the final stage in the activation (our catalyst is gray-green after hydrogenation; $Cl_4Pd_2(P\emptyset_3)_2$ is an orange-red complex and Pd olefin complexes are yellow). Instead, one can assume that further reactions cause the formation of the active species. This might well be Pd(0), as small metal particles or as zero valent Pd-phosphine clusters, because a monophosphine complex is probably not as resistant to reduction as a bisphosphine complex. At present, we are investigating this aspect and will report the results later.

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Flavor Perceptibility of Straight Chain, Unsaturated Aldehydes As a Function of Double-Bond Position and Geometry

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ABSTRACT

The mean threshold values for odor and taste of straight-chain mono- and diunsaturated aldehydes are determined in solutions of paraffin oil. The threshold values lie at low concentrations and display interesting odor and taste aspects. Special attention is given to the influence of chain length, double-bond position, number of double bonds and *cis/trans* geometry.

INTRODUCTION

In 1964, we published some data about the odor and taste of a number of saturated and unsaturated straight-chain aldehydes in paraffin solutions (1). An interesting pattern of odor and taste aspects was obtained if the threshold values were plotted as a function of the chain length within a homologous series or within a series of aldehydes having the same chain length and with none, one or two double bonds in the molecule.

Considering these results, we continued our study with straight-chain mono- and diunsaturated aldehydes. Special attention was given to chain length, double-bond position, number of double bonds and *cis/trans* geometry.

The data may prove valuable for researchers working on taste and odor aspects in fruits, oils, fats and other fields.

EXPERIMENTAL

The aldehydes were synthesized as described in the literature (2,3). The odor and taste threshold values were determined in spectroscopically pure (tasteless) solutions of paraffin oil according to Patton and Josephson (4). Duplicate determinations were done according to ref. 1.

RESULTS AND DISCUSSION

Table I gives a survey of the average threshold values for odor and taste, and flavor descriptions of the aldehydes synthesized. The alternating taste threshold values found earlier for the homologous *trans*-2-alkenals were also determined for the homologous series of alkenals with the iso-

lated double bond at the terminal (n-1, vinyl group; Table IIA), *cis*-(n-2) (Table IIB), and *cis*-(n-3) position (Table IIC). Minimal odor and taste threshold values were found for 5-hexenal, *cis*-4-hexenal, *cis*-4-heptenal, respectively. The minimal odor and taste threshold values found for the aldehydes in each series, as mentioned in Tables II-IV, were defined as having by far the most intense flavor strength with respect to the other aldehydes of the same series.

Homologous series of alkenals with a *trans*-isolated double bond in the (n-2) (Table IID) and (n-3) position (Table IIE) showed no alternating effect; minimal threshold values were found for *trans*-6-octenal and *trans*-6-nonenal, respectively.

In studying the influence of the double-bond position on

TABLE I
Flavor Strength of Mono- and Diunsaturated Aldehydes Dissolved in Paraffin Oil

Substance	Threshold (mg/kg) Odor	Taste	Flavor description
Hexenal			
trans-3-	1.2	1.2	Green, odor of pine-tree needles
cis-3-	0.11	0.11	Green beans, tomato green
cis-4-	0.002	0.00055	Green, creamy, methional-like
5-	0.019	0.022	Green, potato peel-like
Heptenal			
trans-2-	14.0	0.63	Bitter almonds
trans-3-	0.31	0.23	Green
cis-3-	0.025	0.01	Green
trans-4-	2.3	0.32	Green
cis-4-	0.010	0.0016	Green, creamy
trans-5-	0.16	0.01	Green
cis-5-	1.0	0.25	Green
6-	0.66	0.068	Green, melon
Octenal			
trans-2-	7.0	1.0	Nutty
cis-3-	0.05	0.035	Green
trans-4-	0.37	0.15	Green, melon-like
trans-5-	0.15	0.032	Cucumber-like
cis-5-	1.0	0.027	Cucumber-like
trans-6-	0.015	0.001	Green, melon
cis-6-	0.040	0.0010	Green, melon
7-	0.51	0.040	Green, melon
Nonenal			
trans-2-	3.5	0.1	Starch glue
cis-3-	0.25	0.035	Green, cucumber-like
trans-4-	2.0	0.04	Reminiscent of LHF[a]
cis-4-	0.08	0.0075	Green, cucumber-like
trans-5-	0.45	0.055	Reminiscent of LHF
cis-5-	0.25	0.025	Green, melon-like
trans-6-	0.0046	0.00032	LHF flavor, melon
cis-6-	0.04	0.002	Melon-like
trans-7-	1.0	0.1	Melon-like
cis-7-	0.4	0.06	Melon-like
8-	1.6	0.32	Melon-like
Decenal			
trans-5-	5.0	1.0	Melon-like
trans-7-	1.55	0.35	Cucumber-like
cis-7-	0.45	0.06	Cucumber-like
trans-2, *trans*-4-heptadienal	10.0	0.46	Rancid hazelnuts
trans-2, *trans*-4-nonadienal	1.0	0.15	Nutty
trans-2, *trans*-5-octadienal	2.5	0.32	Cucumber-like
trans-2, *trans*-6-nonadienal	0.21	0.018	Tallowy, green
trans-2, *trans*-7-decadienal	1.0	0.32	Green, plant-like

[a]Linolenic hardening flavor.

TABLE II
Influence of Double-Bond Position and Geometry on the Flavor Perceptibility of Various Monounsaturated Aldehydes: Mean Threshold Values of Taste and Odor in mg/kg

		Aldehydes C6:1	C7:1	C8:1	C9:1	C10:1
A	Double bond	5	6	7	8	
	Taste	*0.019*	0.068	*0.040*	0.32	
	Odor	*0.022*	0.66	*0.51*	1.6	
B	Double bond	*c*4	*c*5	*c*6	*c*7	
	Taste	*0.00055*	0.25	*0.0010*	0.60	
	Odor	*0.002*	1.0	*0.040*	0.40	
C	Double bond	*c*3	*c*4	*c*5	*c*6	*c*7
	Taste	0.11	*0.0016*	0.027	*0.0018*	0.057
	Odor	0.11	*0 010*	1.0	*0.036*	0.42
D	Double bond		*t*5	*t*6	*t*7	
	Taste		0.010	*0.0010*	0.10	
	Odor		0.16	*0.015*	1.0	
E	Double bond	*t*3	*t*4	*t*5	*t*6	*t*7
	Taste	1.2	0.32	0.032	*0.00032*	0.31
	Odor	1.2	2.3	0.15	*0.0046*	1.55

TABLE III
Influence of the Double-Bond Position on the Flavor Perceptibility of Various Monounsaturated Aldehydes: Mean Threshold Values of Taste and Odor in mg/kg

	Double-bond position 2	3	4	5	6	7
trans-Heptenal						
Taste	0.63	*0.23*	0.32	*0.010*	0.068	
Odor	14.0	*0.31*	2.3	*0.16*	0.66	
trans-Octenal						
Taste	1.0		0.15	0.032	*0.001*	0.040
Odor	7.0		0.37	0.15	*0.015*	0.51
cis-Nonenal						
Taste		0.035	*0.0075*	0.025	*0.002*	0.06
Odor		0.25	*0.08*	0.25	*0.04*	0.4
trans-Nonenal						
Taste	0.1		0.04	0.055	*0.00032*	0.1
Odor	3.5		2.0	0.45	*0.0046*	1.0

TABLE IV
Influence of the Position of the Second Double Bond on the Flavor Perceptibility of *trans*-2, *trans*(n-3)-Alkadienals: Mean Threshold Values of Taste and Odor in mg/kg

	Aldehyde C7:2 *t*2,*t*4	C8:2 *t*2,*t*5	C9:2 *t*2,*t*6	C10:2 *t*2,*t*7
Taste	0.46	0.32	*0.018*	0.32
Odor	10.0	2.5	*0.21*	1.0

the flavor perceptibility of monounsaturated aldehydes having the same chain length (Table III), we found alternating odor and taste threshold values for the *trans*-(n-x)-heptenals and *cis*-(n-x)-nonenals (5). Minimal values were determined for *trans*-3- and *trans*-5-heptenal, and for *cis*-4- and *cis*-6-nonenal. The *trans*-nonenals showed only an alternating effect for the taste threshold values; minimal values were for *trans*-4- and *trans*-6-nonenal. The odor threshold values for the *trans*-nonenals and the odor and taste threshold values for the *trans*-octenals had only one minimum, viz., for *trans*-6-nonenal and *trans*-6-octenal, respectively.

The homologous series of *trans*-2, *trans*-(n-3)-alkadienals (Table IV) had one minimum for the odor and taste threshold value, viz., for *trans*-2-*trans*-6-nonadienal.

Earlier investigations (6), in which the thin layer chromatographic behavior of these unsaturated aldehydes were studied as 2,4-dinitrophenylhydrazone derivatives on silver-nitrate-impregnated chromatoplates, showed similar results. However, no answer has been found yet in what way these thin layer chromatographic phenomena can be collated with the odor and taste aspects of unsaturated aldehydes in the free state. Basic organoleptic investigations of these compounds, using animal odor and taste receptors, might better elucidate the mechanism of smelling and tasting.

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Rapeseed Meal in Animal Nutrition: II. Nonruminant Animals

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ABSTRACT

On the basis of our present knowledge regarding the use of rapeseed meal in rations for swine and poultry, it would appear that the usage levels for high glucosinolate and low glucosinolate rapeseed meals discussed in this paper should give excellent results in terms of performance.

INTRODUCTION

Undoubtedly, the most important factor that has contributed to expansion of usage of rapeseed meal (RSM) in feeds for swine and poultry in recent years has been the development of low glucosinolate (LG)-type rapeseed (RS) by Canadian and European plant breeders. Releases of LG cultivars of RS in Canada have been more rapid than in Europe and, as a consequence, Canada has led the world in production of this type of RS. About two-thirds of Canada's 1979 crop of 154 million bushels of RS was of LG type. It is expected that ca. 80% of Canada's 1980 crop of RS will be of the LG cultivars Tower, Regent, Candle and Altex.

Because RSM derived from LG-type RS has been shown to be decidedly superior for feeding purposes to meal produced from high glucosinolate (HG)-type RS, which is still grown in many countries of the world, the Canadian RS industry has settled on the name "Canola meal" to identify RSM produced from Canadian LG-type RS. All of the RSM currently being produced in Canada is of LG type.

COMPOSITION

Protein and Amino Acids

The protein content of RSM varies, depending on the cultivar from which the meal is produced. The protein content of RSM from Candle RS runs around 35% whereas that from Tower, Regent or Altex runs 38-39%.

The amino acid composition of LG-RSM does not differ from that of HG-RSM (1). From the point of amino acids in RSM vs those in soybean meal (SBM), RSM protein is lower in lysine and higher in sulfur-containing amino acids than SBM. As a consequence, these two protein-rich feedstuffs tend to complement each other when used together in rations.

Studies on the variability in the quality of the protein of commercial RSM have been undertaken,. In this connection, Goh et al. (2) found a high correlation between the dye-binding capacity of the protein (DBCP) of RSM with Acid Orange 12 and the basic amino acid contents of the meals. However, in subsequent studies of the DBCP of a large number of commercial RSM and their total protein efficiency ratios for chicks, no relationship was evident (3). It was concluded from this study that Canadian RS processors are producing RSM of consistently high quality.

TABLE I

Recommended Levels of Use for Rapeseed Meal for Nonruminant Farm Animals

	High glucosinolate (%)	Low glucosinolate (%)
Swine		
Starter, grower, finisher	5	10
Breeder	3	—[a]
Chickens		
Starter, grower	15	20
Layer, breeder	5	10
Turkeys		
Starter, grower	10	20
Breeder	10	10

[a]May be used as the sole source of supplementary protein.

[1] Presented at the ISF/AOCS World Congress, New York City, April 1980.