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Keeping quality and freshness determination of *Sardinella aurita*

A. Herzberg, Rachel Pasteur and Miriam Rosenblatt
Ministry of Agriculture, Israel

Summary

The storage life of iced *Sardinella aurita* is about 5 to 7 days. Covering the fish with a layer of crushed ice on board the fishing boat immediately after catch does not improve their apparent quality on arrival in the harbour but lengthens their storage life by 24 to 48 hours. The advantage of immediate icing at sea shows up after 2 to 3 days in cold storage when fish, iced without delay, are of better quality than fish iced only at unloading in the harbour.

The enzymatic hypoxanthine determination (Jones, 1964) gives better correlation (r=0.895) with sensory quality evaluation of *S. aurita* in the Eastern Mediterranean than either trimethylamine (r=0.544) or total volatile bases (r=0.502) determination.

Values of 2.0 μ mol hypoxanthine, and over, per gram of minced fish muscle indicate that the fish is not suitable for human consumption.

Résumé

La durée de conservation de la *Sardinella aurita* gardée dans la glace est d'environ 5 à 7 jours. Le fait de recouvrir le poisson d'une couche de glace pilée à bord du bateau de pêche immédiatement après la prise n'améliore pas la qualité apparente du poisson à l'arrivée au port, mais allonge sa durée de conservation de 24 à 48 heures. L'avantage de la mise immédiate dans la glace à bord du bateau se manifeste après 2 à 3 jours de stockage en chambre froide car les poissons placés dans la glace immédiatement sont de meilleure qualité que ceux placés dans la glace au moment de leur débarquement au port.

La détermination enzymatique de l'hypoxanthine (Jones, 1964) donne une meilleure corrélation (r=0.895) avec l'évaluation sensorielle qualitative de *S. aurita* en Méditerranée Orientale que la détermination de la trimethylamine (r=0.544) ou des bases volatiles totales (r=0.502).

Les valeurs de 2.0 μ mol d'hypoxanthine, et au delà, par gramme de muscle de poisson haché indiquent que le poisson n'est pas apte à la consommation humaine.

Resumen

La vida de almacenamiento de la *Sardinella aurita*, conservada en hielo, es de alrededor de 5 a 7 días. El cubrimiento del pescado con una capa de hielo, machacado a bordo del barco pesquero inmediatamente despúes de la captura no mejora su calidad aparente a la llegada al puerto, pero alarga la vida de almacenamiento en 24 a 48 horas. Las ventajas del recubrimiento inmediato por hielo en el mar se manifiestan despúes de 2 a 3 días de almacenamiento en frío: el pescado cubierto de hielo sin demora es de mejor calidad que el pescado recubierto de hielo solamente en el momento de descarga en el puerto.

La enzimática determinación de hipoxantina (Jones, 1964) da mejor correlación (r=0.895) con la evaluación de calidad sensorial de *S. aurita* en al Mediterráneo Oriental, que la determinación de las bases volátiles totales (r=0.502) o la trimetilamina (r=0.544).

Los valores de 2.0 μ mol de hipoxantina, o superiores, por gramo de músculo de pescado triturado indican, que éste no es adecuado para el consumo humano.

Introduction

Sardinella aurita is the most important fish from the local catch in the Israeli canning industry; by far the major part of the pelagic catch belongs to this species, small quantities of *Sardinella maderensis* and *Dussumieria productissima* are caught as well, and are recorded in the statistics, together with *S. aurita* as 'sardines'.

TABLE 1. *Chemical composition of* S. aurita

Source	*Protein* %	*Oil* %	*Ash* %	*Water* %
Milone (1896)	17.2	0.5–4.9	1.0	78.7
Tulsner (1965)	18.0–21.6	2.3–17.0	0.7–2.6	68.0–76.0
Herzberg & Pasteur (1969)	17.0–22.3	0.4–20.0	1.4–2.9	69.9–78.1

Quantities caught in Israel during the last few years were 900 tons for 1974, 1,600 tons for 1973 and 1,900 tons for 1972 (Sarid, 1975).

The biology of this species is summarized by Ben-Tuvia (1960). It is a widespread species, found off western Africa and Brazil, where it reaches a total length of up to 35 cm. Catches for 1972 included 132,000 tons for Brazil, 142,000 tons in the SE Atlantic (Angola) and 643,000 tons in the eastern central Atlantic (FAO, 1972). In the Israeli catch in the eastern Mediterranean, like most other fish, it is smaller and reaches a size of up to 18–20 cm total length. The fat content and chemical composition, which are important to the canning industry, have been described for western Africa by Tulsner (1965), for the Italian catch by Milone (1896), for the eastern Mediterranean by El Saby (1973) and by Herzberg and Pasteur (1969). The chemical composition is summarized in Table 1.

The purpose of this work was twofold: first to determine how long *S. aurita* can be kept under ice in a fresh, edible and acceptable condition for the canning industry; and second, to find an objective chemical method for freshness determination which is parallel to the evaluation of quality according to flavour, taste, texture and general appearance of these fish at different stages of storage.

Doubts about freshness of fish stem from two sources:

(a) Quality is not necessarily good or bad; freshness of any fish changes from excellent towards rejection through many intermediate steps.

(b) Consumers and potential buyers do not necessarily agree on the degree of freshness or spoilage. A fish may well be fresh and acceptable to one person and spoiled and rejected by another. Therefore a chemical method is needed; one compound (trimethylamine, hypoxanthine) or a complex of substances (total volatile bases) is measured.

Materials and methods

Taking the fish samples

Fish were brought to the laboratory during the period June 1972–September 1973. They were bought at the wholesale fish auction in the Kishon harbour on the day after capture. In every case 'storage age' was recorded. The fish were covered with ice either in the harbour or upon arrival at the laboratory, about one half hour later. In one trial, some of the fish were iced on board immediately after capture and some after arrival in the laboratory. The fish were kept in ice in plastic containers with holes in the bottom, which were put into another plastic box for draining and kept under refrigeration at 4°C or in an insulated box without refrigeration. Fish of different sizes, at different seasons and from various fishing vessels were used in order to obtain results reasonably representative of the average commercial catch.

Preparation of the samples

Samples of 5–6 small fish or 2 medium to large fish were analyzed regularly for a period of up to 11 days. The fish were scaled, gutted, headed and cleaned, the rump was sliced into one inch pieces, from which, after being mixed, samples were taken for organoleptic and chemical tests.

Sensory estimation

The sensory estimation was carried out by laboratory staff, (3 to 4 people). The samples were first judged on account of their colour, odour, firmness of the flesh and general appearance, and, after being kept for 35 minutes in a closed petri dish over boiling water, they were tasted for flavour, odour and texture. Marks were given according to a 5-point scale (Table 2).

TABLE 2. *Organoleptic rating of the samples*

Mark	Evaluation
5	Completely fresh, very good to excellent
4	Fair to good
3	Some off-flavour, slightly rancid, still acceptable
2	Marginal, almost spoiled, rancid
1	Bad, spoiled, rejectable

Chemical methods

Three chemical methods for freshness determination have been used and compared to the sensory evaluation made by the laboratory workers. Total volatile bases (TVB), as described by the Israel Standards Institute, were determined on samples of 10 grams; trimethylamine (TMA) as determined by Dyer (1959) and hypoxanthine (Hx) estimated as uric acid, as described by Jones (1964), were determined on samples of 25 grams each.

Results

Development of TMA, Hx and TVB in comparison to the sensory evaluation of *S. aurita* was followed in seven experiments, conducted during June–July 1972, October 1972 and during April, June and September 1973. Results are shown in Figures 1 to 7.

Influence of fish size

Differences between size groups are noticed in TMA development and to a lesser degree also in Hx and TVB. There is, however, no constant relationship between these parameters and fish size, as in experiment no. 1 the small fish show less TMA than the large ones but approximately equal Hx and sensory evaluation (Figure 1) whereas in experiment no. 3 medium sized fish show less TMA and Hx than the small ones but more TVB; sensory evaluation in this case indicates a slightly better quality of the medium sized fish (Figure 3).

Influence of ice

The influence of early icing was shown in experiment no. 4 which was the repeat of a previous field test made without subsequent chemical freshness determination. On arrival at the harbour, both lots of fish, iced or un-iced at sea, looked alike to laboratory workers as well as to fishermen and buyers. Soon afterwards, in the laboratory, a difference was noted both by chemical and sensory tests. TMA as well as Hx and TVB values were higher for un-iced than for iced fish during subsequent storage in ice, and these results were confirmed by the organoleptic tests made on the same samples (Figure 4). Fish which had not been iced at sea were stale at 4 days and completely spoiled after 6 days whereas fish iced at sea were still acceptable at 4 days and stale to spoiled at 6 days. This showed that covering the fish with ice as early as possible lengthened its storage life by one to two days.

Experiment no. 7 was made at suboptimal storage conditions so as to be more representative of commercial practice. In spite of the fact that the fish were in prime condition at the beginning of the trial, they spoiled more rapidly (during 4–5 days) not being kept constantly under a layer of ice (Figure 7).

Parameters of fish deterioration

Trimethylamine (TMA): TMA values for fresh fish ranged from 0.2–1.5 mg/100 g and for unacceptable fish between 1.2–2.8 mg/100 g (Figure 8) with the exception of one lot of fish (TL 15.0–22.5 cm) which showed a high TMA content from the third day of storage (Figure 1). Although the averages of the different trials show a steady linear increase in TMA content corresponding to the samples as measured by organoleptic evaluation (Figure 8), a closer look at the different trials shows that, initially, fluctuations of TMA content occur during storage (Figures 1, 2, 3, 5 and 7) and that during the final stage of storage (near spoilage) a decrease in TMA is liable to occur.

As stated before, fish size apparently has some bearing on TMA content (Figures 1 and 3) and the differences in TMA between fresh and spoiled fish are not very great and sometimes even overlap in the range of 0.4–2.0 mg TMA/100 g fish. The region of no overlap was below 0.4 mg/100 g for fresh and above 2.0 mg/100 g for stale fish, as shown in Figure 8.

Total volatile bases (TVB): A slight overall increase in TVB content occurred during storage of fish on ice. However, TVB values ranged from 22.5 mg/100 g to 30 mg/100 g for fresh fish as well as for spoiled fish (Figure 9). This overlap stems from the fact that TVB values do not increase gradually during storage on ice but fluctuate without apparent connection to fish deterioration. In some trials, the initial value of TVB was even higher than its value during subsequent storage and, in several cases, it went down during the last days although the fish were almost completely spoiled (Figures 4, 6 and 7).

Hypoxanthine (Hx): The gradual accumulation of Hx during storage on ice was followed for up to 11 days. Fresh fish contained up to 1.4 micromole Hx per gram of minced fish muscle. Values of 1.5–2.0 μ mol/g indicated doubtful quality, and more than 2.0 μ mol/g was found in spoiled to inedible fish. This is demonstrated clearly in Figure 10, which shows also, that hardly any overlap occurs in the values between mark 4 ('Good to fair') and mark 2 ('Marginal, almost spoiled, rancid') of the organoleptic rating (Table 2), whereas mark 3 ('Some off-flavour, slightly rancid, still acceptable') rates in between.

Discussion and conclusions

Regression lines of TMA, TVB and Hx on organoleptic scores are drawn in Figures 8, 9 and 10 respectively. A low correlation coefficient (r) was calculated for TMA (r=–0.533) as well as for TVB (r=–0.567). A greater correlation was found for Hx (r=–0.876) which shows that this parameter should be preferred to both TMA TVB for objective freshness determination of *S. aurita.*

Values of 2.0 micromoles Hx, and over, per gram of fish muscle, indicate that the fish is not suitable for human consumption either fresh or as a canned product.

The shelf life of *S. aurita* kept on ice in cold storage ranges from about 5 to 7 days. The trip from the fishing grounds to the harbour takes a few hours only and the catch generally arrives in a reasonable state of freshness. Covering the fish with a layer of crushed ice on board the fishing vessel, immediately after capture, lengthens its storage life by 24 to 48 hours. although it does not improve its apparent quality on arrival. The advantage of icing the fish at sea immediately after capture shows up clearly after they are kept for 2 to 3 days in cold storage when fish iced at sea look definitely more fresh than fish from the same catch which were iced only at unloading in the harbour.

Acknowledgement

Thanks are due to Mr S. Pisanty of the Fishery Technology Unit for his help in the statistical analysis of the results.

Figure 1
Changes in TMA, Hx and organoleptic rating of two size groups of *S. aurita* during storage in ice (Experiment 1)

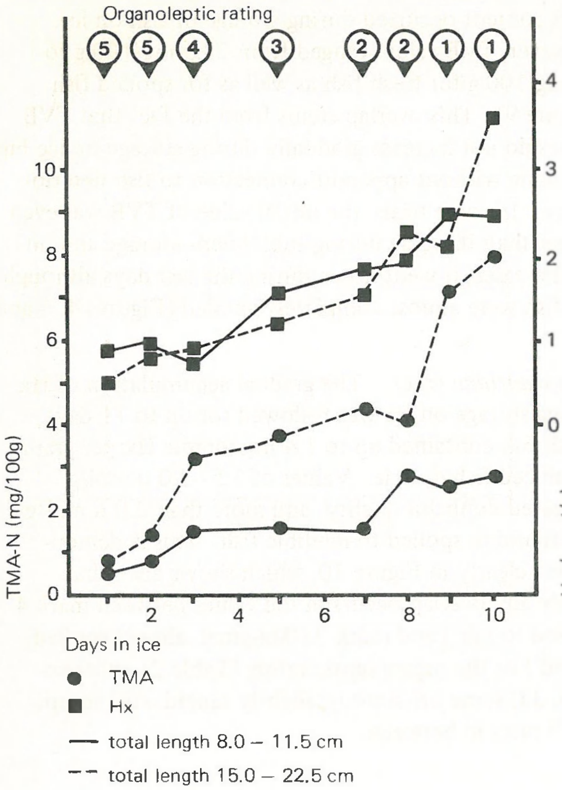


Figure 2
Changes in TMA, Hx and organoleptic rating of muscle of *S. aurita* during storage in ice (Experiment 2)

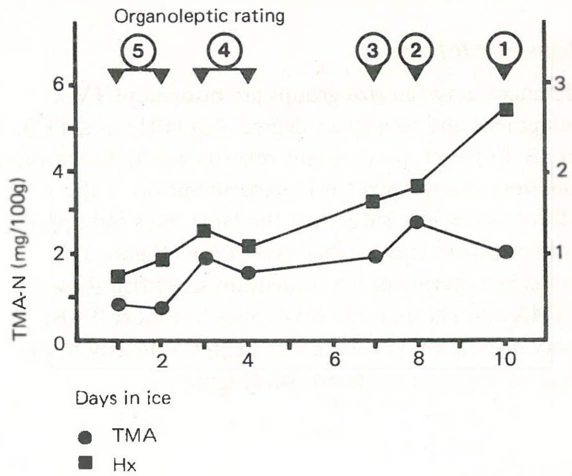


Figure 3
Changes in TMA, Hx, TVB and organoleptic rating of muscle from two size groups of *S. aurita* during storage in ice (Experiment 3)

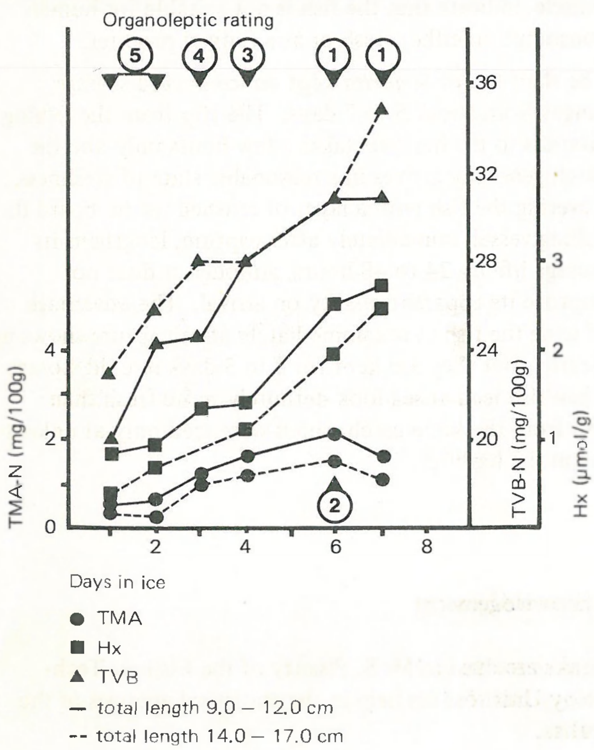


Figure 4
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita during storage in ice (Experiment 4)**

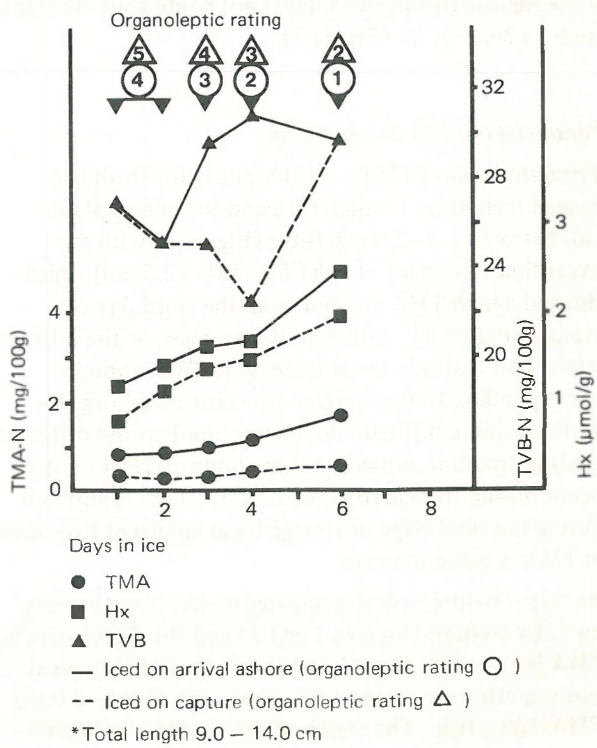
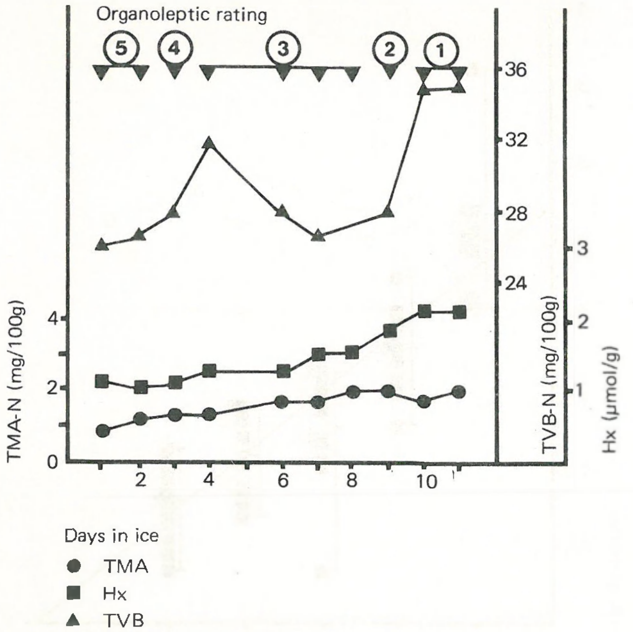
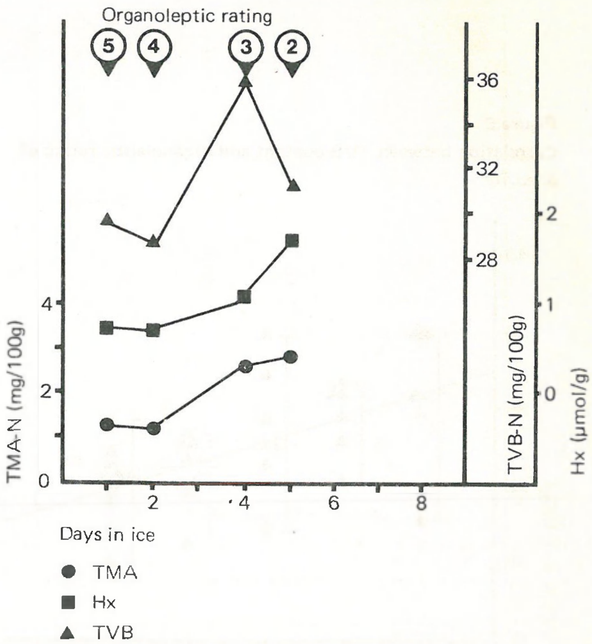


Figure 5
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita during storage in ice (Experiment 5)**



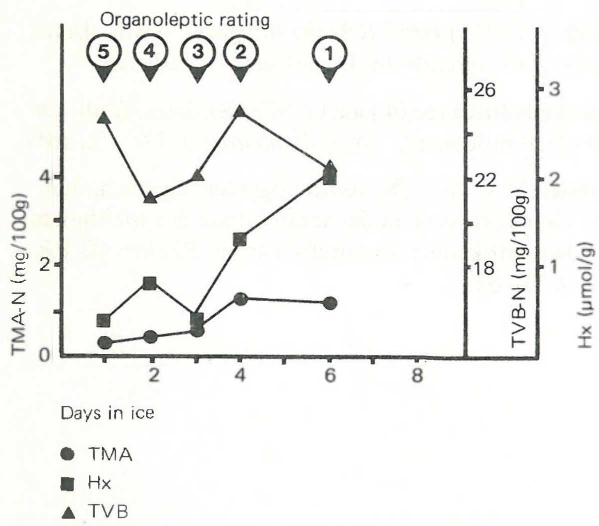
*Total length 10.0 – 17.0 cm

Figure 6
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita during storage in ice (Experiment 6)**



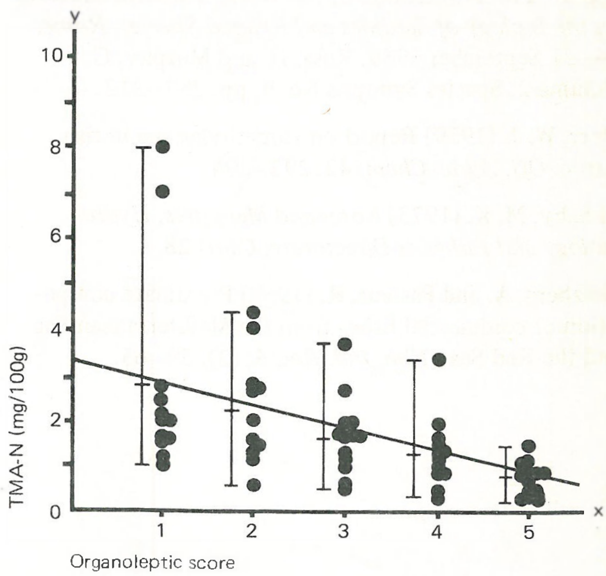
*Total length 18.0 – 20.0 cm

Figure 7
Changes in TMA, Hx, TVB and organoleptic rating of muscle of *S. aurita during storage in ice under suboptimal conditions (Experiment 7)**



*Total length 13.0 – 16.0 cm

Figure 8
Correlation between TMA content and organoleptic rating of *S. aurita*



$y = 3.296 - 0.518\,x$
$r = -0.533$

Figure 9
Correlation between TVB content and organoleptic rating of *S. aurita*

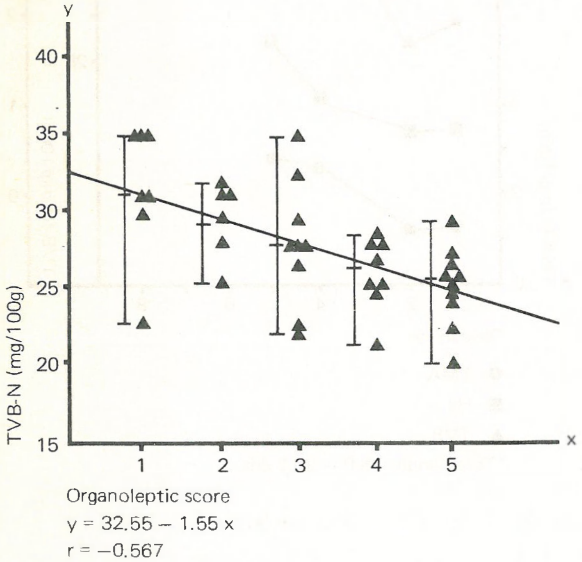
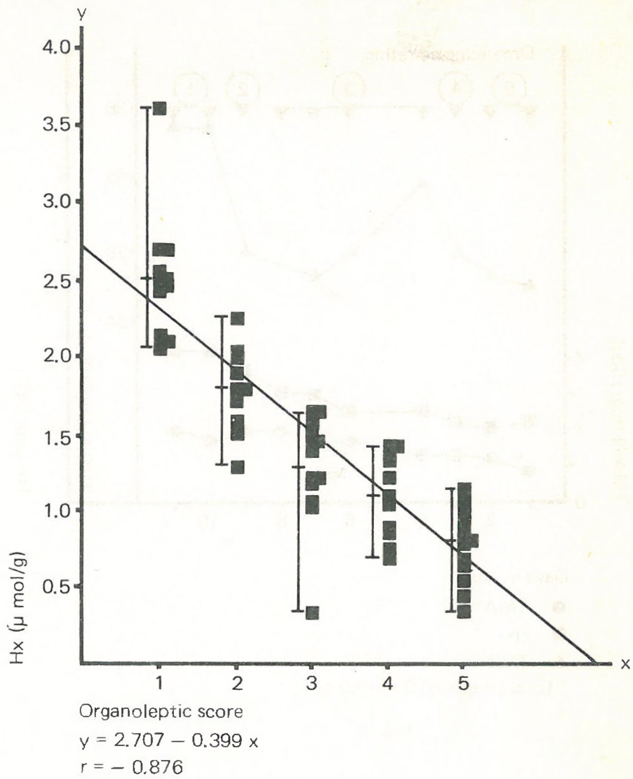


Figure 10
Correlation between Hx content and organoleptic rating of *S. aurita*



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