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Zusammenfassung

In dieser Arbeit werden eingangs die allgemeinen Anforderungen geprüft, die an eine Lebensmittelverpackung gestellt werden. In einigen Beispielen werden dann die besonderen Anforderungen an das Packmaterial, insbesondere an die neueren Verpackungsstoffe, besprochen. In einem zweiten Teil der Arbeit werden die verschiedenen Untersuchungsmethoden für Packungsmaterialien angegeben. Zahlreiche Prüfverfahren, einschließlich Lagerungstests, werden diskutiert im Hinblick auf ihre Vorteile und Beschränkungen. Typische Resultate werden in Tabellen und graphischen Aufzeichnungen wiedergegeben.

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Vacuum Packaging of Coffee in Flexible Foil Laminates *

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Roasted coffee as a luxury is judged by its odour, taste and flavour, while its stimulating effect is due to the content of caffeine and other organic nitrogen compounds. Caffeine as a chemically very resistant compound requires no special packaging, but all the aromatic substances produced in the roasting process are very sensitive to oxygen and moisture. Most of these aromatic compounds, especially organic sulphides, aldehydes and ketones are very susceptible to oxidation, losing their flavour by reaction with oxygen. We also know that coffee contains considerable amounts of oil and fatty compounds with flavour-bearing molecules dissolved in the oily phase of the coffee. This gives an explanation why rancidity is produced as soon as coffee has come into contact with air. All the oxidation reactions are accelerated by light rays, higher temperature and moisture. We must

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also expect that some of the aromatic compounds in roasted coffee will diffuse through the walls of containers which are not completely impermeable.

Roasted coffee is evolving carbon dioxide which is produced by pyrolytic reactions in the roasting process. The amount of released carbon dioxide depends on the type of coffee and the storage temperature and increases with the intensity of the roasting process.

The chemical and physical reactions just mentioned take place much more rapidly in ground coffee due to the greater surface of the powder compared with that of the beans. Therefore, finely ground coffee will need a minimum degassing period.

Consequently we have to consider three aspects in coffee packaging:

1. Removal of oxygen, which means a vacuum package or a pack which has been flushed with an inert gas after evacuating.

2. Production of a package which is impermeable to oxygen, water vapour, flavour-bearing components, light rays. It must maintain extreme barrier values and high vacuum under changing climate conditions as well as under mechanical stress in packaging process and transport.

3. The problem of oxygen absorption by coffee particles, and of carbon dioxide evolution by roasted coffee, will be overcome by a suitable interim storage period under oxygen-free conditions. Evolution of carbon dioxide can also be controlled by powders which can absorb gases (1), especially in the case of vacuum-packed coffee beans. But these new technics are in the state of experimental use only.

For a long time only tins were thought to provide the required properties, but recently an increasing number of coffee packagers have been using flexible packs. Development of high-performance film-foil-laminations has contributed to a breakthrough in flexible packaging of perishable foods with critical shelf-life. At the same time flexible packing cuts about 25 % from the material costs of keyless cans (2); only one operator is needed for the entire packaging equipment. In flexible packaging these extreme specifications can be met with aluminium foil as a component of the laminate. Aluminium foil in a minimum gauge of 0,0005 inch (= 0,0125 mm) has to be coated or laminated with an easily heat sealing medium, preferably polyethylene but in spite of providing good barrier properties in uncreased condition, a combination foil/polyethylene is not sufficient for manufacturing three-dimensional pouches. Soft foil has an elongation figure of only 3 %, making it susceptible to mechanical damage, formation of pin-holes and cracking under the high stress to which it is subjected in the complicated folding and sealing operations, particulary on the sharp corners and edges which arise. This disadvantage can be overcome by laminating foil to plastic films with a high load-bearing capacity, for example polyester, cellulose-acetate, cellophane, orientated polypropylene.Elongation of aluminium foil can be increased in this way up to 30 % with suitable laminating technique using chemically reacting adhesives with high flexibility (3). Moreover, good abrasion properties, high toughness, reasonable stiffness, tear strength, impact strength and resistance to the action of heated sealing bars will be provided by this laminating practice.

Table 1

Physical properties of aluminium foil 0,012 mm, compared with that of the laminate: polyester 50 gauge/foil 0,012 mm/polyethylene 0,070 mm

	alu-foil	laminate
tensile strength kg/mm²	5,5	4,2
bursting strength kg/cm²	0,45	4,5
elongation %		
longitudinal	2,2	37
cross	2,1	28,5

We should now consider the impermeability of packaging materials. Impermeability has to be established not only in the flat surface but also in the seam and in creased and folded areas. Permeability figures for uncreased laminates have been calculated (4). These figures are extremely low, ranging between 10^{-6} and 10^{-4} ml/m²/24 hours for oxygen and water vapour. Permeability in such low ranges cannot be exactly measured. Careful laminating technics using suitable plastic films in optimal gauges will garantee the extreme barrier properties of an uncreased foil laminate to remain still intact after creasing and folding. In three-dimensional packs we have cross seams in which 4 thicknesses of laminate have to be sealed and we think these areas, above all, to be responsible for the permeability of a pack.

Looking for a maximum shelf-life in respect of quality retention for their product, specialists of Usego, a leading Swiss coffee packager, introduced their ground highquality coffee vacuum-packed in a threeply foil laminate made of aluminium foil 0,0005 inch, one side laminated to 50 gauge polyester film, the other side combined with polyethylene film of 65—70 microns. In the packages a high vacuum of about 15 mm of mercury residual pressure can be maintained for several months, and one year's experience by Usego has fully confirmed all the optimistic forecasts. There are also corresponding test results from German and American investigators (1, 2), according to which the shelf-life of ground coffee vacuum-packed in foil laminates was about three times longer than when packed in transparent plastic film combinations like polyester/polyethylene, and shelf-life in vacuum packs was also longer than in nitrogen-flushed gas packages.

Lower results for transparent vacuum packs are due to their higher permeability rates for oxygen (2), causing losses of vacuum in the range of 50—100 mm during a 4 weeks storing period (5), accompanied by loss of flavour. Shelf-life of transparent packs can be extended by incorporating of a coating of polyvinylidene chloride in the laminate and this will provide an adequate shelf-life in many cases.

It should be noted that results in coffee packaging research depend on type, quality and pretreatment of the coffee as well as severity of organoleptic judgement by taste panel.

The remaining air content after evacuation is of great influence on coffee shelf-life in an impermeable pack, reduction of the vacuum from 10 to 70 mm after the final sealing operation may reduce the saleability limit of quality from 6 to 2 months under comparable storage conditions (6). Automatic filling and packaging machines such as Hesser, SIG or CEKAVAC provide high initial vacuum figures in the packs, corresponding to 5—15 mm of mercury residual air pressure, that is, an oxygen content of about 0,2 % in the package.

The Hesser Vacufin, for example, working at speeds from 60—80 packs per minute, cuts pieces of laminated packaging foil from roll stock, forms and seals a rectangular liner, encloses it in a printed cardboard outer package, and then fills the inner pouch with a controlled quantity of ground coffee. The packs are put in separate circulating vacuum chambers, evacuated and sealed, resulting in a rock-hard package. Average waste at the Usego plant in one year due to not fully evacuated or not carefully sealed packs was as low as 0,2 % ranging from 0,03 to 0,5 % for different fabrication periods. The foil laminate used should have excellent machinability in order to avoid troubles and interruptions in the automatic packaging process, which would be accompanied by increasing waste.

Troubles may sometimes be caused by using packaging material with a tendency to curling due to dissimilar tensile strength of polyester and polyethylene film, or material which doesn't provide the required stiffness, or material with too high a total gauge, causing difficulties in the last sealing operation after evacuating. This operation, performed by electric shock sealing and succeeding pressing is most sensitive in respect to sealing temperature and the following dwelling time as well as to thickness of the laminate and heat seal characteristics of the inner film.

Crumbled packaging laminate of higher gauge or dwelling bars which are not carefully adjusted or other deficiencies sometimes cause incomplete sealing with pores in the seam allowing ingress of oxygen. Therefore, the gauges of the components of foil laminates have to be chosen carefully, the laminating process to be controlled with respect to low tensions, and suitable storage conditions for the packaging material should be provided.

Finally it should be mentioned that the rectangular form of the vacuum coffee packages offers some remarkable advantages as regards rigidity, easy stacking, efficient use of storage room, effective display, and easy disposability.

Summary

Aromatic substances and fatty compounds of roasted coffee are very susceptible to oxidation. Deterioration is accelerated by moisture and light. Maximum shelf life for high quality roasted coffee can be achieved by packing under vacuum using impermeable packaging material. High-performance film-foil laminations are providing extreme barrier values as well as good mechanical properties. In vacuum packages made of three-ply laminates including aluminium foil high vacuum can be maintained for several months corresponding to a minimum shelf life of one year.

Résumé

Les agents aromatiques du café torréfié ainsi que ses composants oléagineux sont soumis à une transformation chimique par la présence de l'humidité et de l'oxygène de l'air et un phénomène de catalyse par la lumière peut se produire. Le café moulu exige, du fait de la grande surface des particules entrant en jeu, une qualité particulière de l'emballage en ce qui concerne l'élimination de l'oxygène, l'imperméabilité à la vapeur d'eau, aux composants aromatiques et à la lumière. Un emballage sous vide, étanche, est présenté pour la conservation de longue durée du café torréfié moulu. Le problème du développement de CO_2, comme effet de la torréfaction, peut être contrôlé par un stockage intermédiaire sous gaz inerte ou sous vide et par une évacuation poussée lors du conditionnement.

En concurrence à la boîte de fer-blanc, des complexes aluminium/plastiques ont été mis au point qui offrent en complément de leur imperméabilité de très bonne caractéristiques mécaniques (ténacité, résistance à l'éclatement Mullen, résistance à la déchirure, comportement à l'allongement). La meilleure imperméabilité aux gaz et à la vapeur d'eau est obtenue par un complexe de trois films obtenu en collant sur une face de la feuille mince d'aluminium, d'une épaisseur de 12 à 15 μm, un film de bonne résistance et d'allongement réduit (p. ex. polyester, pellicule cellulosique, polypropylène orienté), alors que l'autre face de la feuille d'aluminium est revêtue d'un enduit thermoplastique à bonnes caractéristiques de scellage à chaud (de préférence du polyéthylène). Les sachets fabriqués à partir d'un tel complexe tiennent un vide résiduaire de 10—15 mm Hg pendant plusieurs mois, ce qui rend possible la conservation du café torréfié moulu pendant 1 année et plus dans ce genre d'emballage.

Zusammenfassung

Die Aromastoffe des gerösteten Kaffees sowie seine Öl- und Fettbestandteile unterliegen in Gegenwart von Luftsauerstoff und Feuchtigkeit chemischen Veränderungen, welche durch Lichteinwirkung katalysiert werden. Gemahlener Kaffee stellt wegen der großen Oberfläche des Pulvers besonders hohe Ansprüche an die Qualität der Verpackung hinsichtlich des Ausschlusses von Luftsauerstoff, der Dichtigkeit gegen Wasserdampf, Aromastoffe und Lichtstrahlen. Eine dichte Vakuumverpackung bietet sich für die Langzeitlagerung von Röstkaffee an. Das Problem der CO_2-Entwicklung als Folge des Röstprozesses läßt sich durch Zwischenlagerung unter Inertgasatmosphäre oder Vakuum und scharfe Evakuierung der abgefüllten Packungen kontrollieren.

Als Konkurrenz zur Weißblechdose wurden im Sektor Vakuumverpackung einige Verbundfolien entwickelt, welche neben der erforderlichen Undurchlässigkeit sehr gute mechanische Eigenschaften aufweisen (Zähigkeit, Berst- und Reißfestigkeit, Dehnungsverhalten). Die höchste Gas- und Wasserdampfdichtigkeit liefern Dreischicht-Verbundfolien, in welchen Aluminiumfolie der Stärke 0,012—0,015 mm auf Filme mit hoher Lastaufnahme und geringer Dehnung kaschiert sind (z. B. Polyester, Cellophan, orientiertes Polypropylen), während die andere Folienseite mit einer thermoplastischen, gut heißsiegelfähigen Schicht (bevorzugt PAe) versehen ist. Aus solchen Verbundfolien hergestellte Raumbeutel halten ein Vakuum von 10—15 mm Hg Restdruck während mehrerer Monate; dies eröffnet die Möglichkeit, gemahlenen Bohnenkaffee 1 Jahr und länger ohne Qualitätseinbuße in solchen Vakuumpackungen zu lagern.

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Vacuum Packaged Cured Meats *

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Introduction

Vacuum packaging ist a process which lends itself successfully to the packaging of a number of foods. The process as applied to cured meats may be divided into two main divisions, according to whether the product is to be packed in the

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